ASSESSMENT OF SAFETY FACTORS AND SAFETY PERFORMANCE IN AFGHANISTAN CONSTRUCTION INDUSTRY

BY

MOHAMMAD HASHIM IBRAHIMKHIL

A Thesis Presented to the
DEANSHIP OF GRADUATE STUDIES

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN, SAUDI ARABIA

In Partial Fulfillment of the
Requirements for the Degree of

MASTER OF SCIENCE

In

CONSTRUCTION ENGINEERING AND MANAGEMENT

May 2017

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS

DHAHRAN- 31261, SAUDI ARABIA

DEANSHIP OF GRADUATE STUDIES

This thesis, written by **MOHAMMAD HASHIM IBRAHIMKHIL** under the direction his thesis advisor and approved by his thesis committee, has been presented and accepted by the Dean of Graduate Studies, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE IN CONSTRUCTION ENGINEERING AND MANAGEMENT.**

Dr. Laith A Hadidi
(Advisor)

Dr. Khalaf Al-Ofi
Department Chairman

Dr. Sadi A. Assaf
(Member)

Dr. Salam A. Zummo
Dean of Graduate Studies

16/5/17

Date

Dr. Abdulaziz Bubshait
(Member)

I humbly dedicate this research to my parents, brother and my wife for their prayers and support throughout my entire master program.

Further, dedicate to all those people who have lost their limbs or lives in construction accidents and to their families who still suffer from these tragedies.

ACKNOWLEDGMENTS

Foremost, I am grateful to almighty Allah (SWT) who made me able to complete my master degree and peace and blessing of Allah be up on His prophet Mohammad (SAW).

I would like heartily thank my thesis advisor Dr. Laith A Hadidi who is a wonderful mentor. His patience, kindness and approachable manner are much appreciated. I consider it a privilege to have worked under the supervision of such a high caliber researcher. I truly believe that this thesis would not have been completed without his magnificent support. In addition, I would like to thank my committee members, Dr. Sadi Assaf and Dr. Abdulaziz Bubshait, who made themselves available when I needed guidance.

I am grateful to my Afghani friends at KFUPM, University classmates and colleagues at Kabul Polytechnic University (KPU) who have helped me a lot in questionnaires distribution and data gathering. I am also indebted for their advices and guidance.

Also, I would like to thank from directorship of Kabul Polytechnic University (KPU), which provided the opportunity to follow my master degree through a merit based scholarship i.e. online international scholarship. In addition, the cooperation of directorship of KPU in data collection is also appreciated.

Finally yet importantly, I am sincerely grateful to my family members who have always kept me in their prayers and offered me their best wishes.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BC	Before Christ
ILO	International Labor Organization
MRRD	Ministry of Rural Rehabilitation and Development
MUDAH	Ministry of Urban Development Affairs and Housing
OSHA	Occupational Safety and Health Administration
PPE	Personnel Protective Equipment
SIGAR	Special Inspector General for Afghanistan Reconstruction
SPSS	Statistical Package for the Social Sciences
TDI	Texas Department of Insurance
USACE	U S Army Corps of Engineers

ABSTRACT

Full Name : [Mohammad Hashim Ibrahimkhil]

Thesis Title : [Assessment of Safety Factors and Safety Performance in Afghanistan Construction Industry]

Major Field : [Construction Engineering and Management]

Date of Degree : [May 2017]

In Afghanistan, the construction industry suffers gravely from safety accidents in construction sites. In general, two major clients are funding construction projects in Afghanistan: government, and U.S Army Corps of Engineers (USACE). Although USACE contractors are theoretically obliged to abide by stringent safety performance on jobsites compared to contractors who work with Afghanistan government, but in reality both types of contractors are claimed to have serious safety violations at the site. Unfortunately, accidents are hidden and not reported for clients. Therefore, no official records of safety accidents are kept to document injury statistics in the country. This research is considered, to the best of our knowledge, as the first attempt to address safety performance in Afghanistan construction industry. The collected data addresses the two types of construction contractors who work in Afghanistan: USACE, and government contractors. The research evaluated fifty-seven contractors and their construction sites (thirty two USACE and twenty five government contractors) working in Afghanistan. The research has two main objectives: first, the assessment of safety factors that affect safety performance and (2) assessment of safety performance level at construction sites on the basis of a comprehensive safety checklist for the construction site.

In the first objective, the research presents a state of the art literature about the critical safety factors (CSFs) in the construction industry that encompassed twenty-nine CSFs. The statistical comparison (Spearman Rho) shows agreement between the two samples: USACE and government contractors. The findings of the research addressed the most important factors for both types of contractors as follow: safety and health training, limitation of PPE, and availability of health and safety policy. The results were compared with neighbor countries (Pakistan, and Iran).

In the second objective, the research develops a safety checklist containing seventeen safety categories. In addition to the Spearman rank correlation coefficient, the Mann-Whitney test is also conducted to test statistically the difference between both types of the projects. Findings of the research show that safety performance level in Afghanistan government's projects and in the USACE projects is poor and very good, respectively. Furthermore, fire prevention, safety administration, PPE, heavy equipment, and handling and storage of materials are the most neglected categories by both types of the contractors.

The research concludes with a set of recommendations that are needed to enhance the safety in Afghanistan construction industry. The findings of this research provides a great value for safety practitioners in the construction industry; it is also hoped that this research will shed the light on safety malpractice in Afghanistan and other similar parts of the world where safety negligence is rampant.

ملخص الرسالة

الاسم الكامل: محمد هاشم ابراهيم خيل

عنوان الرسالة: تقييم عوامل وأداء السلامة في صناعة التشييد في أفغانستان

التخصص: هندسة وإدارة التشييد

تاريخ الدرجة العلمية: شعبان 1438هـ

تعاني صناعة البناء والتشييد في أفغانستان بشكل خطير من حوادث السلامة في مواقع البناء. بشكل عام، هناك مصدريين رئيسيين لتمويل مشاريع البناء في أفغانستان: الحكومة، وفيلق مهندسي الجيش الأمريكي (USACE). على الرغم من أن مقاولين USACE نظريا لديهم اجراءات أكثر صرامة للتقيد السلامة العامة في مواقع العمل بالمقارنة مع المقاولين الذين يعملون مع الحكومة الأفغانية، إلا أنه في واقع الأمر كلا النوعين من المقاولين لديهم انتهاكات خطيرة للسلامة في مواقع البناء. لسوء الحظ، هذه الحوادث لا يتم اخبار العملاء بها ولذلك، لا توجد احصاءات رسمية لعدد الاصابات الخاصة بحوادث السلامة في البلاد. هذا البحث يعتبر، على حد علمنا، أول محاولة لمعالجة أداء السلامة في صناعة التشييد في أفغانستان. البيانات التي تم جمعها في هذا البحث تتناول كلا النوعين من مقاولين البناء الذين يعملون في أفغانستان: USACE، والمقاولين الحكوميين. وقيم البحث سبعة وخمسين متعاقدا بالإضافة إلى مواقع البناء التي يعملون بها (اثنان وثلاثون من USACE وخمسة وعشرون متعاقدا حكوميا) يعملون في أفغانستان. وللبحث هدفان رئيسيان: أولا، تقييم عوامل السلامة التي تؤثر على أداء السلامة وثانيا، تقييم مستوى أداء السلامة في مواقع التشييد على أساس قائمة شاملة للسلامة في موقع البناء.

في الهدف الأول، يقدم البحث آخر ما توصلت إليه الأبحاث حول العوامل الأساسية للسلامة (CSF) في صناعة البناء والتشييد التي تضم تسع وعشرين عاملا (CSFs). وتبين المقارنة الإحصائية (Spearman Rho) التشابه والاتفاق بين العينات: USACE والمقاولين الحكوميين. أوضحت نتائج البحث أهم العوامل لكلا النوعين من المقاولين على النحو التالي: التدريب على السلامة والصحة، محدودية معدات الوقاية الشخصية، وتوافر سياسة الصحة والسلامة. وتمت مقارنة النتائج مع الدول المجاورة (باكستان وإيران).

وفي الهدف الثاني، يطور البحث قائمة مرجعية للسلامة تحتوي على سبع عشرة فئة من فئات السلامة. وبالإضافة إلى معامل ارتباط رتبة Spearman، تم إجراء اختبار Mann-Whitney أيضا لاختبار الفرق بين كلا النوعين من المشاريع إحصائيا. وقد تبين من نتائج البحث أن مستوى أداء السلامة في مشاريع الحكومة الأفغانية "ضعيف" ومشاريع USACE "جيد جدا". وعلاوة على ذلك، فإن الوقاية من الحرائق، وإدارة السلامة، ومعدات الوقاية الشخصية، والمعدات الثقيلة، والتعامل مع المواد وتخزينها هي الفئات الأكثر إهمالا من كلا النوعين من المقاولين.

ولخص البحث بمجموعة من التوصيات اللازمة لتعزيز السلامة في صناعة التشييد في أفغانستان. بالإضافة الى أن نتائج هذا البحث توفر قيمة كبيرة للعاملين على السلامة في صناعة البناء والتشييد. ومن المأمول أيضا أن يلقي هذا البحث الضوء على سوء الممارسة الخاصة بالسلامة المتفشي في مشاريع البناء في أفغانستان وغيرها من بلدان العالم.

CHAPTER 1

INTRODUCTION

Construction industry is known to have a major impact on global economic growth where millions of workers are employed intensively to execute expanding projects. It is widely known that construction workers are seriously prone to many incidents with the risk to have injuries (Enshassi et al. 2013). Construction companies have moral, legal, and financial obligations to provide a safe work environment that ultimately should have zero incident environments. The International Labor Organization (ILO) stated that "the concerned work should be safe and conditions on the construction site should not cause damage to life, health and professional skills"(International Labor Organization, 1995). Unfortunately, in many parts of the world, construction safety issues and precautions are not considered by management (Le et al., 2014). This is due weak safety legislations in such countries (especially developing countries). For instance, in China the death toll of construction industry is larger than the coal mining (Shuai and Li, 2013). Even for developed countries, construction injuries are still high e.g. in 2013, the United States has fatal injuries in construction industry three times more than injuries in other workplaces (Konda et al., 2016). Ideally, safety bylaws mandate that construction companies need to have a proactive control for injury levels by being fully prepared to deal with incidents when they occur, and promoting the safety practices in the work site. It is also highly recommended to undertake proper investigations and reporting procedures when any incident occur even without injuries (near miss).

Accident statistics manifest the terrible human tragedies about deaths related to construction industry where a 100,000 workers per year are estimated to be killed on construction sites worldwide (Murie, 2007). In addition to the loss of priceless human lives, incidents may incur hefty economic costs related to damages in properties and loss of productive work time (Enshassi et al., 2007). Although, the safety issues pertaining the construction industry are crucial in almost all countries still some countries were unfortunate to have rudimentary skills to implement these issues in their construction industry. In fact, many countries had a long history of unfavorable political instability that lead to weak law enforcement and poverty. Indeed, research in construction safety in such countries will help the government and researchers to understand deficient safety practices in the local industry especially where almost no research is there.

In this research, we address the safety practices related to the construction industry in Afghanistan where a very limited safety research studies exist. The research shed the light on construction safety practices to measure the awareness of the critical factors that influence safety practices at construction sites in Afghanistan. The critical factors are identified based on the best safety practices in the literature. Statistical analysis will be used to rank critical safety factors based on the perception of construction project managers. In addition, the research will provide an assessment checklist of the construction site to help management to cover deficiencies in their safety practices.

1.1 Construction safety in Afghanistan

Afghanistan was unfortunate to suffer decades of civil war, which caused tragedies and severely damaged the infrastructure of the country. The construction industry was not

stable enough to sustain continuous growth. The construction industry was devastated with violence and lack of authority. In 2002, with the establishment of a new government in Afghanistan, the construction industry started to establish itself back as it were before the civil war. The US Army Corps of Engineer (USACE) funded many reconstruction projects to rehabilitate the country's devastated infrastructure. Similarly, the Afghanistan government also received funds for reconstruction projects. In fact, the construction projects were booming and attracting local workers. The safety and health regulations were required in all official construction contracts for both USACE and Afghanistan government contractors.

Although contractors are expected to consider safety regulations as per contract documents but in reality, the construction workforce suffer gravely from injuries and fatalities. What makes it worse is that no official records were kept to document statistics about major injuries and fatalities. In fact, companies were convincing injured workers not to claim their injuries as that will affect their chances to win new contracts. Sadly, the company usually takes advantage of the workers poverty and offers them some money as a compensation. Other than injuries, frequent safety violations, cause reduction in productivity, late delivery of projects and budget overrun.

In safety management, it is always better to be proactive i.e. prevent the incident before it occurs. The prevention of construction accidents usually entails predicting future incidents to reduce the risk of injuries and deaths. The major causes of accidents are related to out-door activities, the unique nature of the industry, complicated operation at construction sites, rapidly changing condition of projects, poor safety management which result in unsafe work methods, equipment and procedures (Vitharana et al. 2015;

Choudhry and Fang, 2008). Hence, defining and controlling these causes will be a key element in any safety plan.

In Afghanistan, safety performance on construction sites needs further scrutiny to promote the culture of safety. Due to existing safety problems in Afghanistan construction industry, a research study is compulsory to discover reasons behind these safety violations and to recommend their prevention measures. Moreover, the reasons behinds safety violations and assessing the current safety practices at construction sites help us to find out answers to the following questions

- What are the most critical factors that affect safety performance in Afghanistan construction industry?
- What is the level of compliance of construction contractors with safety and health regulations in construction sites?

Several countries and international organizations including US Army Corps' of engineers Afghanistan district, USAID, World Bank are financial supporters of construction projects in Afghanistan. Although, the funding sources are different but generally the Afghanistan government and U.S Army Corps are the clients of the projects. Therefore, two different categories of construction companies are included in the study: contractors who work with the U.S Army Corps of Engineers (USACE) and the contractors who work with the Afghanistan government. Hence, the third question, which is answered, is:

- What is the difference between safety performance of the contractors work with U.S Army Corps of engineers and the contractors who work with Afghanistan government?

For the USACE projects, the Special Inspector General for Afghanistan Reconstruction (SIGAR) which was founded by the U.S. government act as a leading oversight authority on Afghanistan reconstruction projects (Special Inspector General for Afghanistan Reconstruction, 2009). Both categories entertain lack of safety related problem as shown in the following examples:

- In 2009, during the construction of secondary school in Kapisa province, SIGAR reported many disobedience of safety regulations. Although safety regulations were clearly written in the contract, workers were reported without Personnel Protective Equipment (PPE) such as head, eye, and hand protection. In fact, many of USACE contractors rarely abide by the safety regulations at construction sites especially within provinces that have security problems. In many cases, the basic use of PPE during working hours was not observed which cuase several safety problems to various projects in terms of time, cost and loss to workers' lives (Mittal, 2016).
- In 2003, during rehabilitation of Jomhoriat governmental hospital in Kabul province 13 labors killed and many more injured. The investigation for this famous tragedy revealed that, apart from technical issues contract parties rarely considered safety regulations and precautions as a priority (RadioAzadi News 2013; CHINADAILY News 2004).

1.2 Research Objectives

This research shed the light on construction safety in Afghanistan with the following main objectives:

- To assess the most critical safety factors that affect safety performance in Afghanistan construction industry based on intensive literature review and industry feedback.
- To assess the safety performance level in construction sites in Afghanistan construction industry.

The above objectives will be helpful to understand the status of safety performances in construction sites and to identify critical factors that affect their safety performance. This will enable government to legislate more effective preventive measures that helps the construction companies to prevent future safety problems. The government can also compare between safety performance of USACE contractors and local contractors in Afghanistan.

The remaining chapters of this thesis are organized as follow: chapter 2 provides detailed literature, chapter 3 discusses the methodology followed in this research, chapter 4 provides analysis and discussion of the data relevant to first objective of this thesis, chapter five presents analysis and discussion of safety performance levels in construction projects related to second objective of the study, and chapter six covers summary of the drawn conclusions as well as the recommendations based on findings in chapter four and chapter five.

Table 1-1 summaries the thesis chapters and demonstrates how each objective will be met in which chapter.

Table 1-1 Summary of thesis chapters and objectives

Objectives	Concerned Chapters
Objective 1	Chapter 4
Objective 2	Chapter 5
Objective 1, Objective 2	Chapter 1, Chapter 2, Chapter 3, and Chapter 6

CHAPTER 2

LITERATURE REVIEW

In general, occupational safety is defined as the approval of appropriate methods with their provided resources to mitigate risks involved in any work related activity or simply it can be defined as protecting human beings from physical injuries (Jannadi and Almishari 2003; Hughes and Ferrett, 2007). The interest of occupational safety is rooted back to the days of ancient Egyptian where inscriptions detail the pyramids construction phases. In another example of the ancient world, Hammurabi established the compensation for permanent injuries. Hippocrates the father of medicine recognized respiratory problems caused by stonecutters. Until middle ages, people were not able to understand the causes of injury and illness; however, in Middle Ages people understood that particular type of work can cause specific injuries and illnesses (D. C. D. Reese, 2008). For example, in 1802, E.I du Pont the founder of Du Pont Company establishing gunpowder in U.S.A knew work related safety risks and said, "We must seek to understand the hazards we live with". This statement was not the law but it was only individual act by employer. However, danger in that time differs from today, but it lays the foundation for current safety and health requirements in construction industry (Klein, 2009).

At the start of the industrial revolution, the interest was for maximizing the productivity of industrial organization without any attention to the work environment. With time, workers started to suffer health problems related to work practices or direct injuries at the

work site. However, there were no obligations employers to compensate injured or ill health workers. After World War II, the labor unions started to gain power to influence legal legislations and hence, new bylaws were issued to guarantee the workers safety at site and eligibility for financial compensations in the case of injuries or health problems. As a result, employers have moral, legislative and economic obligations to look for the safety of their workers. Later in 1970, the U.S congress passed the OSHAct to ensure safe and healthy working conditions for every man and women in the United States. With establishment of Occupational Safety and Health Administration (OSHA), work environment completely changed. The injuries and illnesses due to work, which already were unknown, were recognized. In addition, workers demographics altered and information about ergonomics, work stress and organization revealed (National Research Council, 2000).

2.1 Construction Industry and Safety

Motivated by the industrial need, a great deal of research is dedicated for work related safety issues. Choudhry and Zahoor, (2016) conducted research regarding strength and weakness of safety practices in Pakistani construction sites. The survey comprised 60 safety practices, which grouped into 13 safety factors. The responses from 152 construction sites showed that safety training was the most neglected factor, while hoist and crane had better performance.

Ardeshir et al., (2014) conducting a research study to investigate the factors influencing safety performance of workers in Khuzestan province of Iran. The research covers eight factors and thirty-three sub-factors organized in questionnaires. Total of twenty-three

responses collected and fuzzy analytical process used for data analysis. The result of the study shows that safety training and safety management commitment toward safety are the first and second important and influencing factors in construction industry of Khuzestan province.

Enshassi et al, (2013) carried out a research study to identify the causes of safety degradation in Palestinian construction projects. The questionnaire survey contained 80 safety factors which were grouped in 19 categories. The findings of the study revealed that Personnel Protective Equipment (PPE) ranked in the first position among other nineteen groups.

Hu et al., (2011) conducted a literature review to identify the factors influencing the risk of falls and injuries. The study is based on 121 articles regarding factors that affect risk of falls and injuries in construction industry. It was worldwide study covered 16 different countries from five continents. The result of the review showed that "working at surfaces and platforms", "workers' behavior and attitudes", and "construction structure and facilities" are the three high ranked factor influencing risk of fall and injuries in construction.

Heravi, & Nabizadeh Rafsanjani, (2011) conducted a literature review of safety factors in construction projects. Factors that affect safety in lifecycle of a project are reviewed and categorized into four main groups; safety approach, safety engineering, safety management and safety on construction site. These four main groups comprise several critical factors that affect safety performance in construction and are important from safety point of view.

Enshassi et al., (2008) investigated the safety performance of subcontractors in Palestinian construction industry. The aim was to evaluate and rank safety factors that affect subcontractors' safety performance. Totally 30 factors reviewed and categorized into two groups the first; increasing injury rate group and the second; decreasing injury rate group. The findings cleared that injury rate decreases while company has a well-defined site safety plan and provide safety training to workers. On the other hand, injury rate increases when workers use old and unsafe equipment and work environment has complex feature.

Aksorn, & Hadikusumo, (2008) investigated the critical factors that affect safety performance in construction sites. The survey covered 80 responses from small and medium size firms in Thailand construction industry. Total of 16 main critical factors used in questionnaire survey. The result showed that management support is the most influential factor among others.

Enshassi et al., (2007) conducted a research study regarding the perception of construction managers towards the safety in Palestine. Based on the literature review 30 factors that directly or indirectly affect safety at construction. These factors grouped into three groups job related, management related and workers related. Forty-two responses collected and the RII was calculated for ranks. The result indicated that main factors leading to accidents are; "lack of supervision and control on workers' adherence to wear personal protective equipment", "lack of regular safety meetings", and the "lack of respect for the few available safety regulations"

Fang et al., (2004) conducted a research study relevant to factors affecting safety performance on construction sites in the United Kingdom. Thirty-two safety factors gathered from literature reviews and interviews then grouped into seven categories. Total 120 responses received from construction companies. The SPSS and Spearman correlation coefficient used for analyzing data. The result of the study indicated five important factors associated with site safety as below; "management talk on safety", "Provision of Safety booklets", "Provision of safety equipment", "providing safety environment", and " appointing a trained safety representative on site.

Tam et al., (2004) carried out a survey to identify elements of poor construction safety management in China. A questionnaire survey was designed by incorporating twenty-five factors affecting construction safety. The survey was conducted in 200 large and small construction companies with 30% response rate. Relative Important Index (RII) used for ranking the factors. The main factors that affect safety performance ranked as important are in below order; "poor safety awareness of firms top leaders", "lack of training", "poor safety awareness of project managers", "reluctant to input of resources to safety", and "reckless operations".

Jannadi, and Bu-Khamsin, (2002) conducted a survey to gather information about those safety factors that influence the safety performance of industrial contractors in Saudi Arabia. The survey covered twenty main factors and eighty-five sub-factors. The result of the study showed that "management involvement", "personnel Protective Equipment (PPE)" and "disaster planning and preparation" are top three factors that influence safety performance of industrial contractors.

Sawacha et al., (1999) investigated about factors affecting safety performance in construction sites in the United Kingdom construction industry. the questionnaire of the survey contains thirty-four questions clustered into seven variables namely; historical information, economical, psychological, technical, procedural, organizational and environmental. Total 120 responses received from participants. Result of the factors analysis suggest the dominant factors influencing safety at construction sites are; " Talk of management about safety", "Provision of safety booklets", "Provision of safety equipment", Assuring a tidy site", " Appointing safety representative", and " Training of operatives on safety'.

2.2 Construction Safety Research in Afghanistan

Since 2002 with establishment of new government in Afghanistan many scholars from different fields have started publishing their research works in international journals. Although these research studies are in different fields but few of them are relevant to safety at construction industry. Therefore, up to date the limited research studies found related to safety at Afghanistan construction industry, which are summarized as below:

Amiri, (2016) studied the occupational safety and health management in construction sites. Total eighty contractors surveyed in this study. The study revealed that construction managers and engineers are not aware of safety management and 2/3 of construction operators do not attend safety training workshops.

Amiri and Hamidi, (2015) investigated about the usage of a standard safety manual in Afghanistan construction industry. The study is based on review of contract documents and interviews with several construction practitioners in Kabul and Herat provinces. The

findings the study showed that a standard safety manual to be applied over the country has not been developed so far.

Amiri et al., (2015) carried out a research study regarding rarely usage of Personnel Protective Equipment (PPE) by construction workers on jobsites. The responded society composed of sixty-four labors in Herat province. The result of the study shows that lack of devoted budget for PPE, Commitment of owner toward providing the PPE, low interest of labors and weak safety culture are the reasons behind rarely usage of PPE by workers.

Table 2-1 Safety factors summary

No	Factors	Author											
		(Aksorn & Hadikusumo (2008)	Enshass et al (2013)	Jannadi and Bu-Khamsin (2002)	Choudhry and Zahoor (2016)	Hu et al. (2011)	(Heravi & Rafsanjani (2011)	Enshassi et al. (2008)	Enshassi et al. (2007)	Fang et al (2004)	Tam et al 2004	Swacha et al (1999)	Ardeshir et al. 2014
01	Design Complexity		*						*				
02	Owner and Main Developer by-laws	*	*			*		*					
03	Weather Condition					*		*	*				*
04	Total Project Cost		*			*		*					
05	Total Project Duration							*					
06	Safety and Health Policy		*		*		*			*		*	
07	Incidents/ Near miss Reporting				*		*						
08	Investigation and Lesson Learning						*						
09	Mechanism for Implementing lesson learned and investigations of incident and near miss				*		*						
10	Evacuation plan/ Fire drill		*	*			*						
11	Risk Assessment												*
12	Safety and Health Training	*	*		*	*	*	*	*	*	*	*	*
13	Personnel Protective Equipment (PPE)	*	*	*	*	*	*	*	*	*	*	*	*
14	Emergency Planning/ Procedure		*	*			*						

Table 2-1 Contniue…

No	Factors	Author											
		(Aksorn & Hadikusumo (2008)	Enshass et al (2013)	Jannadi and Bu-Khamsin (2002)	Choudhry and Zahoor (2016)	Hu et al. (2011)	(Heravi & Rafsanjani (2011)	Enshassi et al. (2008)	Enshassi et al. (2007)	Fang et al (2004)	Tam et al 2004	Swacha et al (1999)	Ardeshir et al. 2014
15	Site Safety Plan, Hazard Safety management				*		*	*	*				
16	Observation of safety practices on jobsite	*	*		*		*	*	*			*	*
17	Safety and health management meetings		*		*				*	*			*
18	First Aid arrangement		*		*						*		
19	Welfare facilities		*	*									
20	Safety signals/ signs/ barricades		*	*	*		*					*	*
21	Work area plan									*		*	
22	Reward (incentive)	*	*		*			*	*			*	*
23	Role of government and engineering society		*						*				
24	Human behavior/ and psychological climate	*	*			*			*	*			*
25	Employees age and experience		*			*		*		*		*	*
26	Skill labors and illiteracy	*									*		
27	Natural environment		*			*		*	*	*		*	
28	Housekeeping/site security plan			*	*						*		
29	Machinery/equipment		*	*			*				*		

2.3 Assessment of Safety Performance at Construction Sites

This part of literature review includes methods of measuring of safety performance in construction and research studies relevant to safety assessment at construction sites. There are several methods for assessment, in current study the checklist method used to assess the safety performance at construction sites. Moreover, the checklist developed based on modification of several safety checklists from different resources as mentioned below:

- Literature review of different journal papers and thesis
- Construction Safety Inspection Checklist (Texas Department of Insurance)
- International labor Organization (ILO) Checklist (International Labour Organization, 1995)

2.3.1 Safety Measurement

Several safety performance measures can be utilized in construction projects. Some have widely used in construction and some recently introduced in construction industry. In some cases, a project might devise a unique measure or utilize a performance measure in a way that is not typical. Some of the safety performance measures are; Lost workday/restricted work activity injuries, OSHA recordable injuries, First aid injuries, Near misses, Jobsite safety inspections, Behavior based worker observations, Worker safety perception surveys and others (Rinker, 2003).

jobsite safety inspections or safety at physical environment of construction industry is assessed with some of the systematic approaches such as; inspections, checklist, job

safety analysis and hazard hunts(Baig, 2001). Audits or inspection, from health and safety point of view, is conducted to assess certain aspect of the work in construction site. The use of safety and health inspection has been shown that audit has a positive effect on construction firms in terms of reducing accidents/incidents compare to companies do not perform audit (D. C. D. Reese, 2008).

The second procedure for assessment is the checklist method. It is a simple and effective tool for measuring construction safety performance. The checklists consist of the items whose presences or absences jeopardize safety operations. Therefore, checklists are helpful to identify the nature and location of hazards and to keep track of abatement efforts (Baig, 2001).

Job Safety Analysis (JSA) is another procedure, which is used to monitor how the activities are performed and help safety professionals to take a detailed look at its inherent hazards. This is a simple technique employs the cooperation of workers and supervisions in the assessment, recognition and control of hazard or it is simply looking to a task and considering a safest way for its completion. The purpose for JSA is to uncover the inherent hazard at jobsite and create a better working environment (C. D. Reese, & Eidson, 2006).

In line with above, the hazard hunt is used to identify the hazards by involving the employees. Although the employees will not know the detail of the safety standards but they will have some idea of the standard that they see daily or face with and based on that can help the supervisor. The procedure for hazard hunt is based on the form distribution

to employees and collection back. Finally the supervisor will review the forms, correct whatever hazard he could, and submit the list of other for safety staff (Baig, 2001)

2.3.2 Safety Assessment

Mosly, (2015) investigated the safety performance of small to medium size construction companies in Saudi Arabia. The study conducted through observation of construction sites. The checklist comprises five aspects of safety categorized as; general construction site, Personnel Protective Equipment (PPE), Heights and fall protection, excavation, and machinery. The result showed that safety performance in Saudi Arabia is poor and need for urgent improvement.

Priyadarshani et al., (2013) carried out a research study to develop safety assessment framework in Sri Lanka. The study has two phase; the first, collecting factors through literature review and piloting them with construction practitioners. The second, categorizing the important factors to develop assessment framework. The result suggests that a benchmark of safety assessment should be carried out with six dominant groups of factors namely; management commitment, management measures, implementation, project nature, individual involvement and economic investment. The assessment framework organized based on safety importance index and safety performance indexes for each sub-factors. On the basis of calculated score for each factor the safety performance is evaluated as poor, satisfactory, good, and very good. The safety performance;

- If the total score is less than 100 the performance is poor
- If the total score is between 100 and 225 the performance is satisfactory

- If the total score is more than 225 the safety performance is good and
- If the total score is equal to 400 the safety performance is very good.

Farooqui et al., (2008) conducted a research study to investigate the safety performance in Pakistani construction industry. A safety performance investigation Performa used in this study. the Performa is comprised of four category covering several aspects of site safety measurements namely: personnel safety, housekeeping, scaffolding safety, and access to height. Data from twenty-one construction sites analyzed and the findings of the studies showed that most of the construction companies lie in the range of extremely unsafe to moderately unsafe which counts about 58% and remains 42% are in the safer range. The safety performance level of companies assessed based on the percentage of safety performance index (%SPI) with following criteria: 0-20% extremely unsafe, more than 20 up to 40% unsafe, more than 40 up to 60% moderately unsafe, more than 60 up to 80% safe, and more than 80 up to100% extremely safe.

Ahmed et al., (2000) conducted a comparative study of safety plans and procedure in three different sites in Hong Kong. The purpose of the study was to outline an effective method for tackling the site safety problems. The study revealed that all three safety plans in three different sites were properly prepared and included most of the issues that affect safety on sites. It was concluded that a properly defined site safety plan is effective method of tackling safety incidents. To delve further into site safety management a checklist was prepared with six main aspects of site safety issues such as: safety policy, safety organization, safety training, program for inspecting hazardous conditions, usage of PPE, and safety promotion.

Fang et al., (2004) categorized several factors in seven divisions through review of literature and collected data from 82 construction projects in China. Correlation and regression analysis was carried out to identify the relation between factors. Based on the three important divisions; organizational structure, economic investment and labor-management relationship, a linear equation was developed for Safety Management Assessment Index (SMAI). Later, in addition to safety performance index (SPI), SMAI applied to six construction projects in Beijing. It was found that safety management in these projects was outstanding, fair and poor. Moreover it also found that SMAI method can be used to assess safety management performance in other projects as well.

HASSAN et al. (2007) assessed the safety level perception of the construction building workers toward safety. The survey conducted in Kuala Lumpur Malaysia, covered five small and five large building construction projects. In addition to safety factors, a checklist used to assess safety performance level in construction sites. The checklist comprised of seventeen divisions similar to checklist that used by Junnadi and Assaf (1998) in their research in Saudi Arabia. The result of the checklist shows difference between small and large projects. Large projects have high and consistent safety level while the small projects showed low and varied safety level.

Jannadi and Assaf, (1998) assessed the safety performance level of small and large construction firms in Saudi Arabia. A checklist with seventeen divisions used for this survey. All divisions comprised of items that are perceived to be important from safety point of view. The result of the study revealed that safety performance in large construction firms is higher than smaller ones. Safety performance in small firms varied widely from maximum 71.78% (good) to minimum 34.43% (poor).

Similarly, Jannadi and Al-Sudairi, (1995) conducted a research about safety management in construction industry of Saudi Arabia. The study covered sixteen small, medium and large construction firms. The questionnaire that used in this study is prepared with yes and no answers. The finding of the study shows that the larger firms have better safety performance than small firms i.e. average injuries frequency rate in large companies is 11% while in small companies 43%. The larger firms paying greater attention than small firms to safety performance at construction sites. For instance, 78% of large firms had safety training for their new workers while 25% of small firms have such training.

CHAPTER 3

RESEARCH METHODOLOGY

This chapter provides detailed information about research methodology. The research relies on qualitative research tools that includes: surveys, semi-structure interviews, and workshops. These tools were used to design the main research instrument that included a detailed description of safety factors and international best practices in the construction safety. These were presented as detailed two main questionnaires: one addressing the critical safety factors in construction, and a construction safety checklist that is used to assess the safety level of the construction site. The two research instruments were used to assess the construction safety practices in Afghanistan construction industry. The analysis of the collected data is to rank the importance of the critical construction safety factors and to assess the safety levels of construction sites.

The research starts with an extensive literature review including books related to construction safety, journal papers, and magazines. Additionally, two international safety bodies, pioneering in labor safety, were surveyed, namely: Texas Department of Insurance (based on OSHA international standards) and International Labor Offices' (ILO) safety regulations. In fact, the publications relevant to safety in Afghanistan are extremely scarce. To the best of our knowledge, this research is the first to scientifically address the construction critical safety factors in Afghanistan. Based on the literature review, the critical safety factors that affect safety performance in construction sites are defined. The factors were culminated into questionnaire to seek the input of construction

professionals on the most critical factors in Afghanistan. The data collected from contractors who work with USACE and contractors who work with Afghanistan's government. A proper sample size is selected given the available information about construction industry in Afghanistan.

The questions were tested through a pilot survey conducted with safety and project managers in Afghanistan. The aim of the pilot survey is to receive the managers' opinions and their perception regarding developed questionnaire based on their work experience in Afghanistan. The pilot survey is conducted to confirm validation and reliability of the research instrument (is it understandable, easy to answer, covering the most relevant questions from practitioners' safety point of view).

Two research instruments are developed to address the two main research objectives: the first assessing of critical safety factors in Afghanistan construction industry and the second safety assessment in construction sites. Figure 3-1 shows the developed research tools based on: literature review of construction critical safety factors, regulation of international safety bodies i.e. International Labor Office (ILO) and Texas Department of Insurance (TDI), interviews with construction industrial practitioner in Afghanistan, and, lastly, Ministry of Urban Development Affairs and Housing (MUDAH) bylaws and construction contractors' classification.

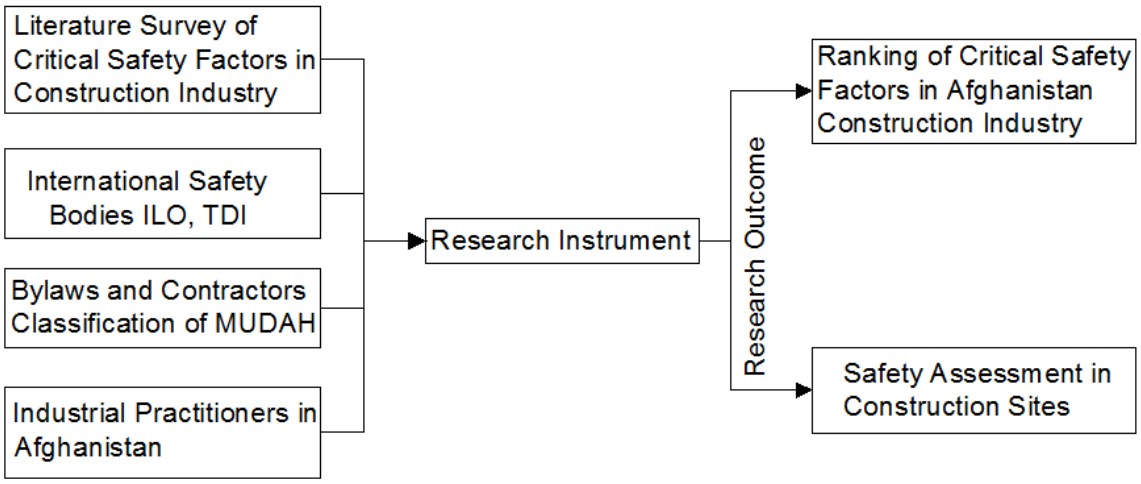

Figure 3-1 Developing research instruments

CHAPTER 4

ASSESSMENT OF SAFETY FACTORS

Afghanistan construction industry has experienced a boom over the last fifteen years when the U.S Army Corps of Engineers (USACE) started to fund projects. Similarly, Afghanistan government also funds many development projects. All contractors are obliged to implement safe practices in the site to qualify for contracts sponsored by USACE and Afghanistan government. Unfortunately, workers in construction projects severely suffer from safety accidents. This research identifies critical factors that affect safety performance in Afghanistan construction industry. The collected data addresses the two types of construction contractors who work in Afghanistan: USACE, and government contractors. The research presents a state of the art literature about the critical safety factors (CSF) in the construction industry that encompassed twenty-nine CSFs. The research evaluated fifty-seven contractors (thirty two USACE and twenty five government contractors) working in Afghanistan. The statistical comparison (Spearman Rho) shows agreement between the two samples: USACE and government contractors. The findings of the research addressed the most important factors for both types of contractors as follow: safety and health training, limitation of PPE, and availability of health and safety policy. Finally, the results were compared with neighbor countries (Pakistan, and Iran)

4.1 Population and Sample Size

This research includes the responses from two types of construction contractors. The first, responses from contractors who work with the Afghanistan's government and the second, responses from construction contractors who work with the US Army Corps of Engineers (USACE) Afghanistan district. There is no official classification of construction contractors in Afghanistan, however, the Ministry of Urban Development Affairs and Housing (MUDAH) has started to classify construction contractors into different levels. So far, 97 of construction companies are classified as first, second, third, fourth or fifth with MUDAH. It is worth mentioning that construction contractors who work with Afghanistan's government include contractors from Kabul Municipality, Ministry of Rural Rehabilitation and Development (MRRD), Ministry of Urban Development Affairs and Housing (MUDAH), and Ministry of Education. Alternatively, construction contractors who work with USACE are not categorized yet and the number of these contractors is not known. However, a list of a 100 active USACE construction contractors are suggested by a professor in Kabul Polytechnic University (KPU) that was used in a previous research. Therefore, the population of the study consists of 97 governments' contractors and 100 USACE contractors.

On the basis of population Targeted, the sample size is calculated by using the below equation (Kish, 1995).

$$n^0 = (p \cdot q) / v^2$$

$$n = n^0 / (1 + (n^0 / N))$$

Where;

n^0= first estimate of sample size

P= Proportion of characteristic being measured in the targeted population

q= 1-P

V= Maximum percentage of standard error allowed

N= The population size

S= Sample size

To get the maximum sample the values of (p) and (q) will be taken as (0.5) for both. The maximum standard error (v) allowed is taken as $(10\,\%)$.

$$n^0 = (0.5 \cdot 0.5)/[(0.1) \cdot 2] = 25$$

$$n = 25/[1 + (25/100)] = 20$$

The sample size required (minimum) is equal to twenty responses. The research received twenty-five responses from USACE, and thirty-two responses from governmental projects.

4.2 Theory and Calculation

During eight months duration, a total thirty-two responses from Afghanistan government contractors and twenty-five responses from USACE contractors have been collected. Majority of the respondents for both types of the contractors were in populated provinces

of Afghanistan. The participants who contributed in current study were in different places e.g. Kabul, Parwan, Wardak, Ghazni, Kandahar, Herat, Khost, Nengarhar, and Balkh provinces.

Furthermore, the following steps are used in this research to come up with the result:

1. An extensive literature review and pilot survey are conducted through which twenty-nine safety factors gathered (Appendix A). These factors are organized with a five-degree Likert scales in questionnaire where number one represents the not importance degree and the number five shows the highest importance degree of the factor.
2. The project managers, safety managers and safety officers of the projects are requested to evaluate the questionnaires. The result of the questionnaire indicates variation in number of these positions for both types of the contractors as shown in Figure 4-1.

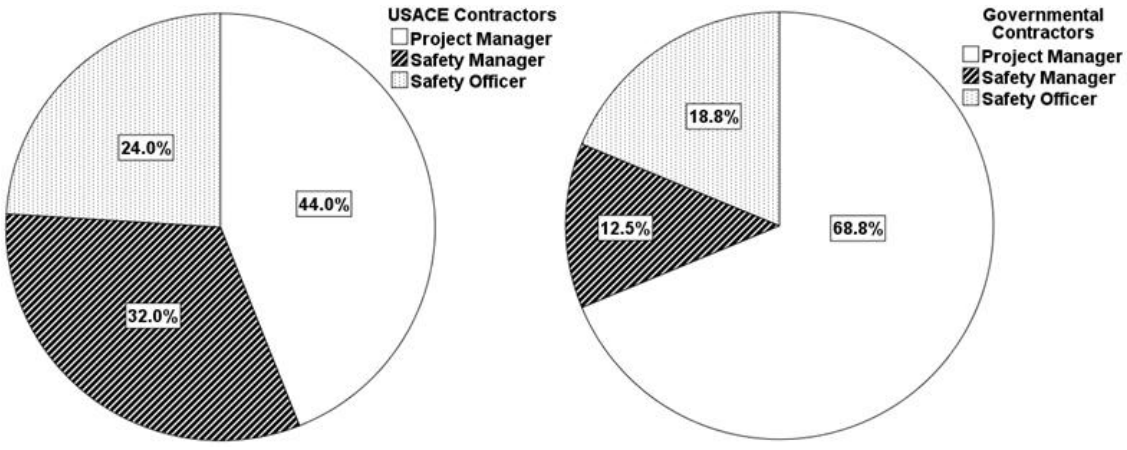

Figure 4-1 Respondents positions distribution

Working experience of respondents also differs in governmental and USACE projects as shown in Figure 4-2.

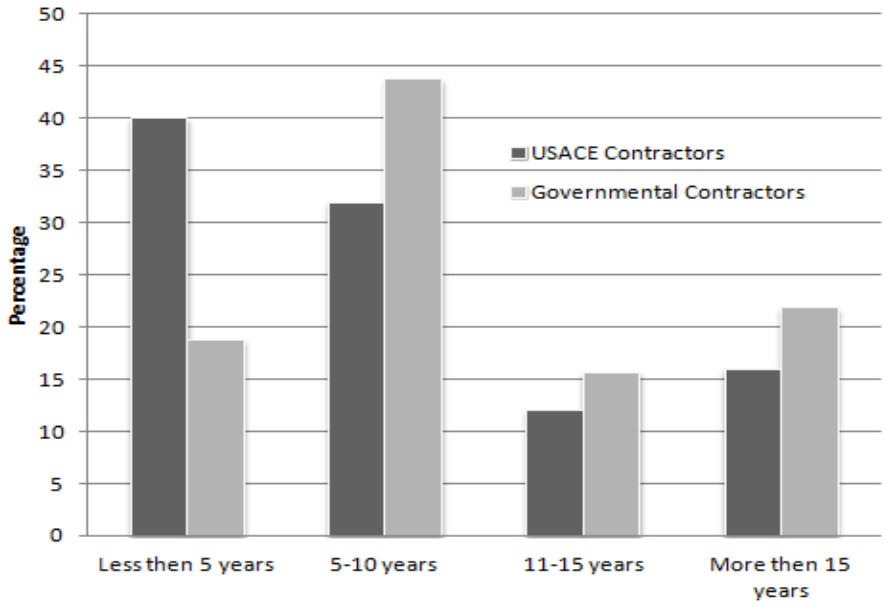

Figure 4-2 Year of experience for USACE and governmental contractors

Figure 4-3 shows the qualification of the respondents. The percentage of bachelor degree is higher than other degrees. It is 78.1% and 65% for the Governmental and USACE contractors respectively. This is the fact that civil war has negative influence on different development fields of a country where Afghanistan is not an exception. Decades of civil war affected the higher education process in Afghanistan as well. Therefore, majority of educated population have undergraduate degrees only.

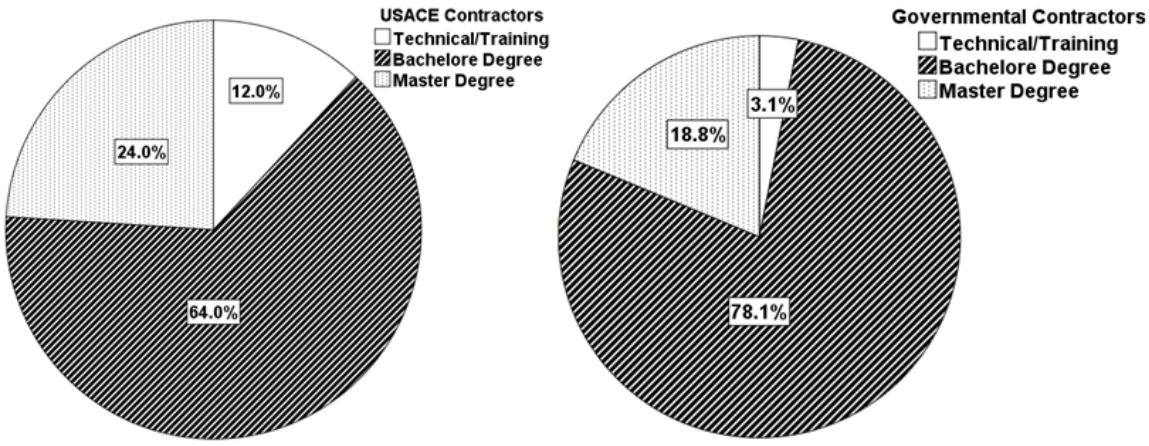

Figure 4-3 Qualification of respondents of contractors

3. The ranking of the safety factors are carried out by using the Relative Importance Index (RII) formula (Tam et al., 2004).

$$RII=\frac{\sum W}{A \cdot B} \qquad (4\text{-}1)$$

Where W is the weighting given to each factor by respondents, ranging from 1 to 5 and A is the highest weight (i.e. 5 in this study) and N is the total number of factors.

To assess these factors, project managers, safety managers/officer were asked to evaluate the factors on the basis of five point Likert importance scale Table 4-1. The Relative Importance Index (RII) calculated to rank these factors. The calculation formula for RII has shown in Equation 4-1;

Table 4-1 Five point Likert scale and importance degree

Letters A, B, C, D, E show the sum of the responses for each factor given by respondents	Importance Degree					RII
	1	**2**	**3**	**4**	**5**	
	Not Important	Less Important	Important	Very Important	Extremely Important	$\frac{5E+4D+3C+2B+1A}{5 \cdot Total\ number\ of\ factors}$
	A	B	C	D	E	

4. The Spearman rank correlation coefficient (Rho) is computed to test the agreement between ranks of both groups of contractors (Jannadi and Assaf, 1998).

$$r_s = \frac{6 \sum D^2}{N(N^2-1)} \qquad (4\text{-}2)$$

4.3 Results

This section contains the assessment of twenty-nine safety factors that affect safety performance in construction sites in Afghanistan. The Statistical Package for the Social Science (SPSS) and MS Excel are used for data analysis. In this research, all the critical safety factors are ranked as per the associated Relative Importance Index (Equation 4-1). The data is collected for both types of the contractors i.e. the governmental contractors and the USACE contractors.

4.3.1 Governmental Contractors

The Relative Importance Index of the factors evaluated by governmental contractors are indicated in Table 4-2. The five most important factors based on the input of governmental contractors are; (1) Adequate safety and health training (2) Availability of safety and health policy, (3) Usage of safety signs/signal/ barricades, (4) Limitation of Personnel Protective Equipment, (5) Planning (Site safety plan, hazard safety management responsibility plan), Observation of safety practices at jobsites and Lack of skill labors and illiteracy.

The result shows that relative importance index score in Afghanistan's government projects is less than USACE projects which indicates that safety awareness in governmental contractors is less than USACE contractors. Although the ranking score is less compare to USACE but there are high ranked factors that are most influential factors in construction sites. Failure to take care of these factors will severely increase the rate of injuries, illnesses and property damages in construction projects.

Table 4-2 Ranks of factors-Afghanistan government contractors

No	Factors	Mean	RII	Rank
01	Adequate safety and health training	3.84	0.77	1
02	Availability of safety and health policy and its impact on safety	3.75	0.75	2
03	Usage of safety signals/ signs/ barricades	3.66	0.73	3
04	Limitation of Personnel Protective Equipment (PPE)	3.63	0.73	4
05	Planning (Site safety plan, hazard safety management responsibility plan, etc)	3.59	0.72	5
06	Observation of safety practices on jobsite	3.59	0.72	5
07	Lack of skill labors and illiteracy	3.59	0.72	5
08	Employees age and experience	3.44	0.69	8
09	Risk assessment	3.41	0.68	9
10	Role of government and engineering society regarding safety of construction companies	3.34	0.67	10
11	Machinery/equipment safe working condition	3.34	0.67	10
12	Investigation and lesson learning from reporting of incident and near miss	3.31	0.66	12
13	Frequently safety and health management meetings	3.28	0.66	13
14	Good housekeeping/site security plan	3.28	0.66	13
15	Owner and main developer by-laws to safety	3.22	0.64	15
16	Natural environment impact on safety	3.22	0.64	15
17	Mechanism for implementing lesson learned and investigations of incident and near miss	3.19	0.64	17
18	Incidents/ Near miss reporting	3.16	0.63	18
19	Arrangement of suitable welfare facilities for workers usage	3.03	0.61	19
20	Availability of First Aid arrangement and medical personnel on jobsite	3	0.60	20
21	Usage of reward (incentive) and warning for safety performance	3	0.60	20
22	Influence of weather condition on safety and health	2.97	0.59	22
23	Impact of total project cost on safety	2.97	0.59	22
24	Emergency planning/ procedure and logistic to hospitalize sever injuries	2.97	0.59	22
25	Usage of work area plan and its impact on safety	2.97	0.59	22
26	Human behavior/ and psychological climate	2.84	0.57	26
27	limitation of evacuation plan/ fire drill	2.66	0.53	27
28	Design complexity impact on safety	2.63	0.53	28
29	Total project duration influence on safety	2.63	0.53	28

4.3.2 USACE Contractors

Ranking method of safety factors identified by USACE contractor's respondents is similar to factors identified by Afghanistan government contractors. The ranks for these factors are calculated as per Relative Importance Index as shown in Table 4-3. The higher is the importance index the higher is the rank of the factor. The four important high ranked factors for USACE contractors are; (1) Safety & health training, Limitation of Personnel protective Equipment, (3) Availability of safety and health policy, (4) Planning, site safety observation at jobsite and usage of safety signs/signals/barricades respectively.

Table 4-3 Ranks of factors-USACE contractors

No	Factors	Mean	RII	Rank
01	Adequate safety and health training	4.56	0.91	1
02	Limitation of Personnel Protective Equipment (PPE)	4.56	0.91	1
03	Availability of safety and health policy and its impact on safety	4.52	0.90	3
04	Planning (Site safety plan, hazard safety management responsibility plan etc.)	4.4	0.88	4
05	Observation of safety practices on jobsite	4.4	0.88	4
06	Usage of safety signals/ signs/ barricades	4.4	0.88	4
07	Risk assessment	4.36	0.87	7
08	Availability of First Aid arrangement and medical personnel on jobsite	4.32	0.86	8
09	Emergency planning/ procedure and logistic to hospitalize sever injuries	4.16	0.83	9
10	Machinery/equipments' safe working condition	4.12	0.82	10
11	Good housekeeping/site security plan	4.04	0.82	11
12	Frequently safety and health management meetings	4	0.80	12
13	Investigation and lesson learning from reporting of incident and near miss	3.92	0.78	13
14	Lack of skill labors and illiteracy	3.92	0.78	13
15	Owner and main developer by-laws to safety	3.8	0.76	15
16	Mechanism for implementing lesson learned and investigations of incident and near miss	3.76	0.75	16
17	Incidents/ Near miss reporting	3.72	0.74	17
18	Role of government and engineering society regarding safety of construction companies	3.72	0.74	17
19	Employees age and experience	3.72	0.74	17
20	Influence of weather condition on safety and health	3.72	0.74	17
21	Arrangement of suitable welfare facilities for workers usage	3.68	0.73	21
22	Usage of work area plan and its impact on safety	3.48	0.70	22
23	Human behavior/ and psychological climate	3.48	0.70	22
24	limitation of evacuation plan/ fire drill	3.44	0.69	24
25	Impact of total project cost on safety	3.4	0.68	25
26	Usage of reward (incentive) and warning for safety performance	3.32	0.66	26
27	Design complexity impact on safety	3.24	0.65	27
28	Natural environment impact on safety	2.96	0.59	28
29	Total project duration influence on safety	2.92	0.58	29

4.3.3 Comparison between USACE and Governmental Ranking

Spearman's rank correlation coefficient or Spearman's Rho which is often donated by Greek letter (ρ) or (r_s) measures the strength and direction of association between two ranked variables. It assesses how well the relationship between two variables can be described using a monotonic function. The Spearman rank correlation coefficient r_s computed for all safety factors that identified by USACE contractors and governmental contractors. It is worth mentioning that, mean of the ranks used for factors that are with same number of ranking i.e. tied ranks as indicated in Table 4-4.

The output of Rho coefficient gives a numerical index of relation between the ranks of the factors based on the following formula.

$$r_s = 1 - \frac{6\sum D^2}{N(N^2-1)} \qquad (4\text{-}3)$$

Where;

D= difference between ranks for the same factor

N= number of factors (in this case 29 factors)

$$r_s = 1 - \frac{6\sum 869.5}{29(29^2-1)} = 0.785$$

A critical value of (r_s) is needed to test the alternative hypothesis (H_a) that USACE and governmental contractors generally agree on the important ranking of the factors against the null hypothesis, which says that there is no association between the ranks. Using the table of critical values of Spearman's rank correlation coefficient (Appendix C), the critical value of (r_s) with $\alpha = 0.01$ level of significance and N=29 is 0.440. Since the calculated value of (r_s) is larger than the critical value from the table, then the null

hypothesis is rejected at $\alpha = 0.01$ level of significance. It appears that there is some agreement between the two ranks in both types of the contractors. Furthermore, the Spearman rank correlation coefficient (r_s) also calculated in SPSS to compare it with manual calculation for confidence. The SPSS value for Spearman rank correlation coefficient has been shown in table 4-5 which is similar to the index achieved by above formula.

Table 4-4 Mean and difference of the ranks

Factors Rank for both types of the projects					
No	**Safety Factor**	**USACE Ranks**	**Gov Ranks**	**Diff**	**Square of D**
01	Design complexity impact on safety	27	28.5	-1.50	2.25
02	Owner and main developer by-laws to safety	15	15.5	-0.50	0.25
03	Influence of weather condition on safety and health	18.5	23.5	-5.00	25.00
04	Impact of total project cost on safety	25	23.5	1.50	2.25
05	Total project duration influence on safety	29	28.5	0.50	0.25
06	Availability of safety and health policy and its impact on safety	3	2	1.00	1.00
07	Incidents/ Near miss reporting	18.5	18	0.50	0.25
08	Investigation and lesson learning from reporting of incident and near miss	13.5	12	1.50	2.25
09	Mechanism for implementing lesson learned and investigations of incident and near miss	16.0	17	-1.00	1.00
10	limitation of evacuation plan/ fire drill	24	27	-3.00	9.00
11	Risk assessment	7	9	-2.00	4.00
12	Adequate safety and health training	1.5	1	0.50	0.25
13	Limitation of Personnel Protective Equipment (PPE)	1.5	4	-2.50	6.25
14	Emergency planning/ procedure and logistic to hospitalize sever injuries	9	23.5	-14.50	210.25
15	Planning (Site safety plan, hazard safety management responsibility plan, etc.)	5	6	-1.00	1.00
16	Observation of safety practices on jobsite	5	6	-1.00	1.00
17	Frequently safety and health management meetings	12	13.5	-1.50	2.25
18	Availability of First Aid arrangement and medical personnel on jobsite	8	20.5	-12.50	156.25
19	Arrangement of suitable welfare facilities for workers usage	21	19	2.00	4.00
20	Usage of safety signals/ signs/ barricades	5	3	2.00	4.00
21	Usage of work area plan and its impact on safety.	22.5	23.5	-1.00	1.00
22	Usage of reward (incentive) and warning for safety performance	26	20.5	5.50	30.25
23	Role of government and engineering society regarding safety of construction companies	18.5	10.5	8.00	64.00
24	Human behavior/ and psychological climate	22.5	26	-3.50	12.25
25	Employees age and experience	18.5	8	10.50	110.25
26	Lack of skill labors and illiteracy	13.5	6	7.50	56.25
27	Natural environment impact on safety	28	15.5	12.50	156.25
28	Good housekeeping/site security plan	11	13.5	-2.50	6.25
29	Machinery/equipments' safe working condition	10	10.5	-0.50	0.25

Table 4-5 Spearman Rho correlation coefficient by SPSS

Correlations

			USACE	GOV
Spearman's rho	USACE	Correlation Coefficient	1.000	.785**
		Sig. (1-tailed)		.000
		N	29	29
	GOV	Correlation Coefficient	.785**	1.000
		Sig. (1-tailed)	.000	
		N	29	29

**. Correlation is significant at the 0.01 level (1-tailed).

The twenty-nine safety factors are evaluated by both types of the contractors that are shown in Table 4-2 and Table 4-3. Generally, the ranking score for safety factors that were evaluated by governmental respondents is less than the score evaluated by the USACE respondents. This made the difference between the highly ranked factors of the two groups Table 4-6. Similarly, the difference between relative importance indexes of all the factors is also depicted which shown in Figure 4-5.

The higher score in ranks of safety factors as well as responses frequency distribution for safety factors that perceived by USACE contractors indicates that safety awareness between USACE contractors is higher than Afghanistan government's contractors and they pay more attention to safety practices in their projects. On the other hand, the responses frequency distributions as perceived by governmental contractors support the idea that there is urgent need to raise the safety awareness in governmental projects Figure 4-4. This will result in a better safety performance in construction sites and mitigate the safety violations.

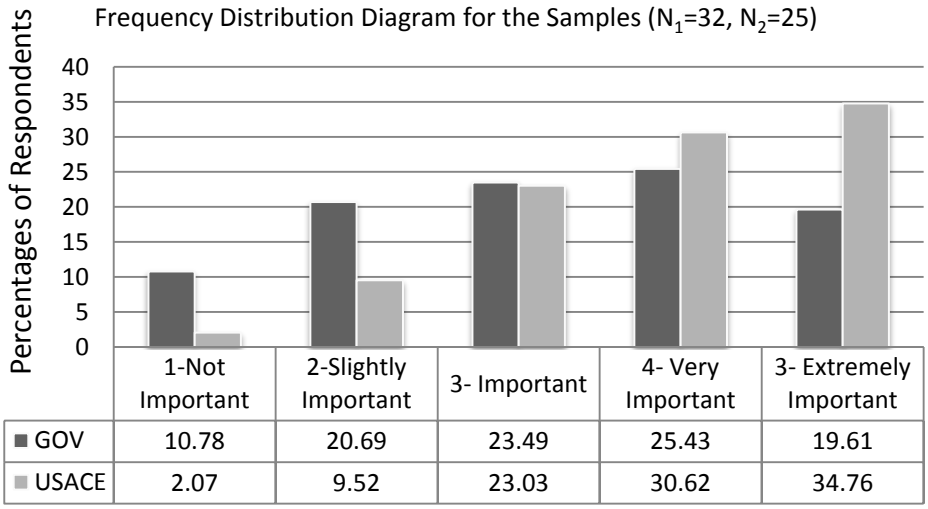

Figure 4-4 Frequency distribtuion of responses

There could be several reasons behind safety awareness and the higher ranks of safety factors in USACE projects compare to governmental projects. Clients' commitments toward safety and health performance in construction sites and enforcing contractors to employ safety personnel at jobsites are considered as dominant factors. In addition, all contract agreements cover the OSHA regulations as part of contract documents while in majority of governmental contracts safety requirements are considered for conventionality only. The Afghanistan government contractors are not committed to safety and health regulations in construction projects. Therefore, safety awareness is less in these projects compare to USACE projects. Furthermore, Afghanistan government is also responsible behind this low level of safety awareness between contractors. Mostly, workers insurance is not considered in governmental contract agreements, which reduces the safety responsibility of contractors. Furthermore, clients do not observe safety at construction sites regularly. This contributes to contractor performance without paying attention to safety regulations.

Table 4-6 Comparison between USACE and government contractors ranks

No	USACE Contractors		Governmental Contractors	
	Factors	**Rank**	**Factors**	**Rank**
01	Adequate safety and health training	1	Adequate safety and health training	1
02	Limitation of Personnel Protective Equipment (PPE)	1	Availability of safety and health policy and its impact on safety	2
03	Availability of safety and health policy and its impact on safety	3	Usage of safety signals/ signs/ barricades	3
04	Planning (Site safety plan, hazard safety management responsibility plan etc.)	4	Limitation of Personnel Protective Equipment (PPE)	4
05	Observation of safety practices on jobsite	4	Planning (Site safety plan, hazard safety management responsibility plan, etc)	5
06	Usage of safety signals/ signs/ barricades	4	Observation of safety practices on jobsite	5
07	Risk assessment	7	Lack of skill labors and illiteracy	5
08	Availability of First Aid arrangement and medical personnel on jobsite	8	Employees age and experience	8
09	Emergency planning/ procedure and logistic to hospitalize sever injuries	9	Risk assessment	9
10	Machinery/equipments' safe working condition	10	Role of government and engineering society regarding safety of construction companies	10
11	Good housekeeping/site security plan	11	Machinery/equipments' safe working condition	10
12	Frequently safety and health management meetings	12	Investigation and lesson learning from reporting of incident and near miss	12
13	Investigation and lesson learning from reporting of incident and near miss	13	Frequently safety and health management meetings	13
14	Lack of skill labors and illiteracy	13	Good housekeeping/site security plan	13
15	Owner and main developer by-laws to safety	15	Owner and main developer by-laws to safety	15

Table 4-6 Continue…

No	USACE Contractors		Governmental Contractors	
	Factors	**Rank**	**Factors**	**Rank**
16	Mechanism for implementing lesson learned and investigations of incident and near miss	16	Natural environment impact on safety	15
17	Incidents/ Near miss reporting	17	Mechanism for implementing lesson learned and investigations of incident and near miss	17
18	Role of government and engineering society regarding safety of construction companies	17	Incidents/ Near miss reporting	18
19	Employees age and experience	17	Arrangement of suitable welfare facilities for workers usage	19
20	Influence of weather condition on safety and health	17	Availability of First Aid arrangement and medical personnel on jobsite	20
21	Arrangement of suitable welfare facilities for workers usage	21	Usage of reward (incentive) and warning for safety performance	20
22	Usage of work area plan and its impact on safety	22	Influence of weather condition on safety and health	22
23	Human behavior/ and psychological climate	22	Impact of total project cost on safety	22
24	limitation of evacuation plan/ fire drill	24	Emergency planning/ procedure and logistic to hospitalize sever injuries	22
25	Impact of total project cost on safety	25	Usage of work area plan and its impact on safety	22
26	Usage of reward (incentive) and warning for safety performance	26	Human behavior/ and psychological climate	26
27	Design complexity impact on safety	27	limitation of evacuation plan/ fire drill	27
28	Natural environment impact on safety	28	Design complexity impact on safety	28
29	Total project duration influence on safety	29	Total project duration influence on safety	28

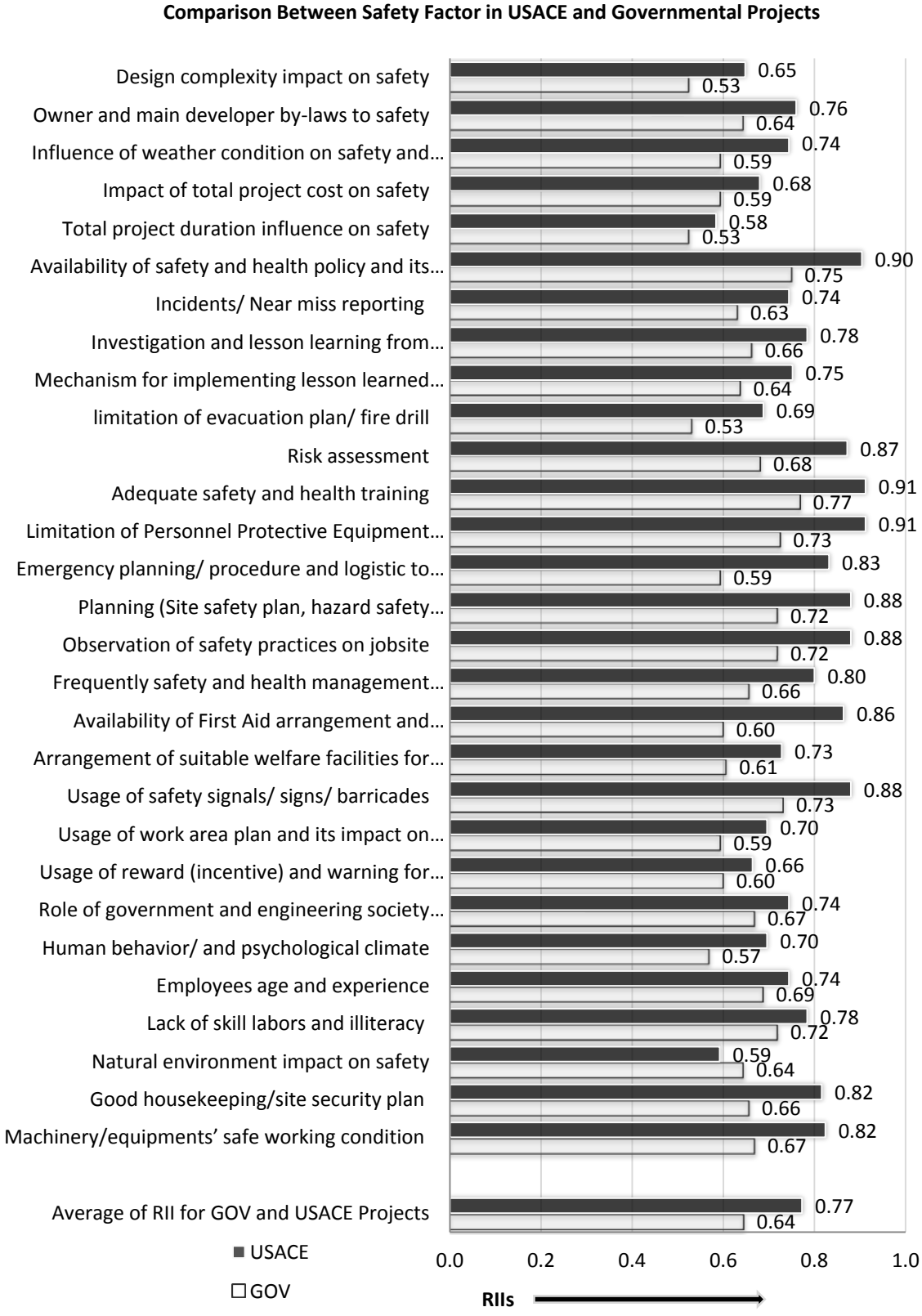

Figure 4-5 Comparison between RIIs of USACE and governmental contractors

4.4 Discussion and Conclusion

In general, the research findings show that contractors' safety awareness of USACE projects is higher than contractors of Afghanistan governmental projects. This is indicated by comparing the score of relative importance index for both types Table 4-7.

Table 4-7 Relative Importance Index values

Projects	Min RII	Max RII	Average of Relative Importance Indexes
GOV Projects	0.53	0.77	0.64
USACE Projects	0.58	0.91	0.77

Although safety awareness in USACE projects is higher, but still further improvement is mandated as the safety practices in Afghanistan projects are considered by many observers rudimentary. A general observation can be stated in Afghanistan is that many practitioners limit their perception of safety by focusing only on PPE rather a complete and comprehensive safety plan. Therefore, some of the critical safety factors are ranked with least importance degree i.e. physical and psychological behavior of worker, total project durations influence on safety, natural environment impacts on safety, design complexity and its impact on safety as shown in Tables 4-2, Table 4-3.

Another point that worth mentioning, there should be an effort to raise the level of safety awareness about the employers' responsibility to provide a safe working environment for their employees. This point is better addressed in USACE contractors as the contracts always explicitly mandate safety requirements. The contract parties including owner, designers and contractors should contribute to create a safe working environment. On the other hand, Afghanistan government should ensure that designers consider safety

regulations as well as the governmental contractors are committed to safety. The government is also encouraged to consider contractors safety work history as one of the key selection factors before the award of the construction contract. Contractors are responsible to create a safe working environment for their workers.

Lack of skill labors and illiteracy (the literacy rate in Afghanistan is 31% of the adult population i.e. over 15 years of age, UNESCO office in Kabul, 2017) between workers also contribute to low safety awareness in Afghanistan construction industry. There are few vocational training institutes with specific vocational training sections which cannot satisfy increasing needs of the construction industry in Afghanistan. In addition, illiteracy between workers is also a dominant factor of low safety awareness between workers. Mostly, workers are not able to read safety signs and regulations at construction sites which result in serious ignorance and violations of safety. To raise the safety awareness and mitigate safety violations, this research reveals the most influential factors in construction safety factors in Afghanistan as shown in Table 4-8. The most influential factors are selected as per RII more than average score of 77% for USACE projects and more than 64 % for governmental projects as shown in Figure 4-5.

Finally, there are several studies regarding ranking of safety factors in other neighbor countries (Pakistan, and Iran) with variations in ranking. In Pakistan, construction industry safety training, safety at contract documents, safety meeting are the most neglected factors among practitioners (R.M Choudhry, & Zahoor, 2016). In Khuzestan province of Iran, it was found that safety training, management, environment and workmanship are the most influential factors in construction projects (Ardeshir et al., 2014). It is widely believed that ranking the critical safety factors and paying attention to

the high ranked factors is one of the proactive approaches of preventing safety violations in construction industry. The difference between influential safety factors in Afghanistan construction industry, Pakistan construction industry and Khuzestan construction industry of Iran is shown in Table 4-9.

In addition, to raise safety awareness between people it is highly encouraged that government should increase the number of vocational institutes in the country. Safety and health training sections should be included in vocational institutes as well as in governmental and private universities. Nowadays, safety and health training is not provided in most of the universities curriculum which keeps safety as unimportant practice and culture in construction industry.

Table 4-8 Most influential factors in both types of the projects

No	USACE Contractors		Governmental Contractors	
	Factors	**Rank**	**Factors**	**Rank**
01	Adequate safety and health training	1	Adequate safety and health training	1
02	Limitation of Personnel Protective Equipment (PPE)	1	Availability of safety and health policy and its impact on safety	2
03	Availability of safety and health policy and its impact on safety	3	Usage of safety signals/ signs/ barricades	3
04	Planning (Site safety plan, hazard safety management responsibility plan, etc.)	4	Limitation of Personnel Protective Equipment (PPE)	4
05	Observation of safety practices on jobsite	4	Planning (Site safety plan, hazard safety management responsibility plan, etc)	5
06	Usage of safety signals/ signs/ barricades	4	Observation of safety practices on jobsite	5
07	Risk assessment	7	Lack of skill labors and illiteracy	5
08	Availability of First Aid arrangement and medical personnel on jobsite	8	Employees age and experience	8
09	Emergency planning/ procedure and logistic to hospitalize sever injuries	9	Risk assessment	9
10	Machinery/equipments' safe working condition	10	Role of government and engineering society regarding safety of construction companies	10
11	Good housekeeping/site security plan	11	Machinery/equipments' safe working condition	10
12	Frequently safety and health management meetings	12	Investigation and lesson learning from reporting of incident and near miss	12
13	Investigation and lesson learning from reporting of incident and near miss	13	Frequently safety and health management meetings	13
14	Lack of skill labors and illiteracy	13	Good housekeeping/site security plan	13

Note: The most influential factors for USACE projects are selected more than average RII score 77% and for governmental projects more than average RII score 64 %.

Table 4-9 Comparison between safety factor of Afghanistan, Iran and Pakistan

<table>
<tr><th colspan="4">Most Influential Factors in Afghanistan Construction Industry</th><th colspan="2">Most influential Factors in Iran (Khuzestan Province) Construction Industry</th><th rowspan="2">Most Neglected Factors in Pakistan's Construction Industry</th></tr>
<tr><th>In Governmental Projects</th><th>Rank</th><th>In USACE Projects</th><th>Rank</th><th>Factors</th><th>Sub-Factors</th></tr>
<tr><td>Adequate safety and health training</td><td>1</td><td>Adequate safety and health training</td><td>1</td><td>Safety Training</td><td>All training toward safety</td><td>Safety training</td></tr>
<tr><td rowspan="2">Availability of safety and health policy and its impact on safety</td><td rowspan="3">2</td><td>Limitation of Personnel Protective Equipment (PPE)</td><td>1</td><td rowspan="3">Management</td><td>Management commitment toward safety</td><td>Safety in contract documents</td></tr>
<tr><td>Availability of safety and health policy and its impact on safety</td><td>3</td><td>Safety observation at jobsites</td><td>safety Meetings</td></tr>
<tr><td rowspan="2">Usage of safety signals/ signs/ barricades</td><td rowspan="2">Planning (Site safety plan, hazard safety management responsibility plan)</td><td rowspan="2">4</td><td>Management safety knowledge</td><td rowspan="2">workers involvement</td></tr>
<tr><td>3</td><td rowspan="3">Environment and workmanship</td><td>Type of the work and workmanship</td></tr>
<tr><td rowspan="2">Limitation of Personnel Protective Equipment (PPE)</td><td rowspan="2">4</td><td>Observation of safety practices on jobsite</td><td>4</td><td>Supervisors understanding from work</td><td rowspan="2">incentives and disincentive for workers</td></tr>
<tr><td>Usage of safety signals/ signs/ barricades</td><td>4</td><td>Weather condition impact on safety</td></tr>
</table>

CHAPTER 5

ASSESSMENT OF SAFETY PERFORMANCE LEVEL

In Afghanistan, the construction industry suffers gravely from safety accidents in construction sites. In general, two major clients are funding construction projects in Afghanistan: government, and U.S Army Corps of Engineers (USACE). Although USACE contractors are theoretically obliged to abide by stringent safety performance on jobsites compared to contractors who work with Afghanistan government, but in reality both types of contractors are claimed to have serious safety violations at the site. Unfortunately, accidents are hidden and not reported for clients. Therefore, no official records of safety accidents are kept to document injury statistics in the country. This research develops a safety checklist containing seventeen safety categories. The checklist is used to assess the safety performance of fifty seven construction projects in Afghanistan (twenty-five USACE projects, and thirty-two governmental projects). The Spearman rank correlation coefficient (Rho) computed for correlation between USACE and governmental projects. In addition, the Mann-Whitney test is also conducted to test statistically the difference between both types of the projects. Findings of the research show that safety performance level in Afghanistan government's projects is poor and in the USACE projects is very good. Furthermore, Fire prevention, safety administration, PPE, heavy equipment, and handling and storage of materials are the most neglected categories by both types of the contractors.

5.1 Population and Sample Size

This research includes the responses from two types of construction contractors. The first, responses from contractors who work with the Afghanistan's government and the second, responses from construction contractors who work with the US Army Corps of Engineers (USACE) Afghanistan district. There is no official classification of construction contractors in Afghanistan, however, the Ministry of Urban Development Affairs and Housing (MUDAH) has started to classify construction contractors into different levels. So far, 97 of construction companies are classified as first, second, third, fourth or fifth with MUDAH. It is worth mentioning that construction contractors who work with Afghanistan's government include contractors from Kabul Municipality, Ministry of Rural Rehabilitation and Development (MRRD), Ministry of Urban Development Affairs and Housing (MUDAH), and Ministry of Education. Alternatively, construction contractors who work with USACE are not categorized yet and the number of these contractors is not known. However, a list of a 100 active USACE construction contractors are suggested by a professor in Kabul Polytechnic University (KPU) that was used in a previous research. Therefore, the population of the study consists of 97 governments' contractors and 100 USACE contractors.

On the basis of population Targeted, the sample size is calculated by using the below equation (Kish, 1995).

$$n^0 = (p \cdot q) / v^2$$

$$n = n^0 / (1 + (n^0 / N))$$

Where;

n^0= first estimate of sample size

P= Proportion of characteristic being measured in the targeted population

q= 1-P

V= Maximum percentage of standard error allowed

N= The population size

S= Sample size

To get the maximum sample the values of (p) and (q) will be taken as (0.5) for both. The maximum standard error (v) allowed is taken as (10%).

$$n^0 = (0.5 \cdot 0.5)/[(0.1) \cdot 2] = 25$$

$$n = 25/[1 + (25/100)] = 20$$

The sample size required (minimum) is equal to twenty responses. The research received twenty-five responses from USACE, and thirty-two responses from governmental projects.

5.2 Theory and Calculation

It is widely believed that the rate of accidents can be reduced if contractors take care to ensure safe working conditions at construction sites. To provide a safe working condition, safety performance inspections should be carried out regularly at construction sites

through various tools. One of the easiest inspection tools to inspect is using a construction site safety checklist comprising important questions from safety point of view. In this research, the checklist is developed based on modification of several construction site safety checklists from different sources as below;

- Literature review of different journal papers and thesis
- Construction Safety Inspection Checklist (Texas Department of Insurance)
- International labor Organization (ILO) Checklist (International Labour Organization, 1995)

The following steps are used in this research to come up with the result:

1. An extensive literature review and pilot survey are conducted through which a checklist with seventeen categories modified (Appendix B). The checklist comprises 104 items (questions) distributed among seventeen categories. Each question is responded with one of the three answers; Yes, No, or Not Applicable and a "not applicable" options is also placed in front of each category. If any of the categories is not applicable in a particular project, the respondents are requested to tick the "Not Applicable" option in front of the category.

2. The collected data is analyzed such that for each "Yes" is given a score of 100 and for each "No" is given a score of zero. The category score is calculated by the following simple formula (Jannadi and Assaf, 1998).

$$\text{Category Score(CS)} = \frac{\sum[\text{no of 'Yes'} \cdot 100 + \text{no of 'No'} \cdot 0]}{[\text{no of applicable items}]} \qquad (5\text{-}1)$$

The score of project is obtained by calculating the average score of the applicable categories within that project. Out of the seventeen categories, eight categories are applicable between all projects of USACE and Afghanistan government. The safety performance level of projects are assessed based on the following scales Table 5-1:

Table 5-1 Safety performance level scales

No	**Safety Level Range (in Percentage)**	**Rating**
01	0 - 59	Poor
02	60 - 69	Fair
03	70 - 79	Good
04	80 - 89	Very Good
05	90 - 100	Excellent

3. The Spearman rank correlation coefficient (Rho) is computed to test the agreement between ranks of both groups of contractors (Jannadi and Assaf, 1998).

$$r_s = \frac{6\sum D^2}{N(N^2-1)} \qquad (5\text{-}2)$$

Where;

D= difference between ranks for the same factor

N= number of share categories between groups (in this study eight categories are applicable for both types of the contractors)

5.3 Results

The checklist, which is used for safety performance inspection in this research, is used into two types of projects, the USACE projects and governmental projects in Afghanistan. A total of fifty seven construction sites were evaluated based on the developed safety checklist where thirty-two construction sites are relevant to governmental projects and twenty-five sites are related to USACE projects.

5.3.1 Safety Performance Level-Governmental Projects

The collected data from thirty-two inspected construction sites of governmental projects is analyzed and the safety performance score is calculated for all the projects separately. The safety performance level is the average score of all applicable categories in a particular project. Rates are also assigned based on the average performance score in Table 5-1. The highest score in governmental projects is 81.7%, which is rated as "very good", and the lowest score is 30.3%, which is rated as "poor". Only four projects rated as "very good" in governmental projects. Moreover, five projects rated as "good", six projects as "fair" and the remaining are rated as "poor" which are shown in Table 5-3. It seems from the Table 5-3 that no project of this group is rated as excellent. Furthermore, the overall average score for safety performance level in Afghanistan's government projects is 58.3%, which is less than 59 and is rated as poor.

In addition, the most neglected categories in Afghanistan governments' projects are also determined. The average score as a percentage is calculated for the same category in all thirty-two projects. This is calculated based on the percentage of negative responses i.e.

"No" for each question within the category. Fire prevention, safety administration, and personnel protective equipment (PPE) are the three most neglected categories in Afghanistan governmental projects which are shown in Table 5-2. A box plot is also provided to display the distribution of the negligence score between the categories as minimum, first quartile, median, third quartile, and maximum as shown in Figure 5-1.

Table 5-2 Ranks of neglected categories-Governmental projects

No	Division	Min Negligence Score	Max Negligence Score	St. Dev	Safety Negligence Index (SNI)	Ranks
01	Jobsite General	0.00	100	30.82	51.20	5
02	Safety administration	0.00	100	36.9	68.96	2
03	Health and welfare	0.00	100	20.42	41.65	10
04	Fire Prevention	0.00	100	30.07	74.38	1
05	Housekeeping	0.00	75	20.46	30.19	11
06	Asbestos and explosive	0.00	100	33.39	45.83	7
07	Excavation	0.00	50	16.91	22.60	15
08	Scaffold/mobile Towers/Ladders	0.00	58.33	17.12	28.52	12
09	Hoist/Cranes and lifting devices	12.50	100	30.68	52.84	4
10	Heavy equipment	16.67	66.67	15.37	42.26	9
11	Personnel protection equipment (PPE)	0.00	100	28.46	62.44	3
12	Formworks	0.00	60	13.55	16.88	17
13	Welding and Cutting	0.00	100	31.15	23.61	14
14	Electrical	0.00	80	25.33	23.95	13
15	Air compressor	0.00	75	33.91	21.88	16
16	Handling and Storage of Material	0.00	100	31.69	45.97	6
17	Flammable liquid/Material and chemical or Acids	0.00	100	35.18	45.00	8

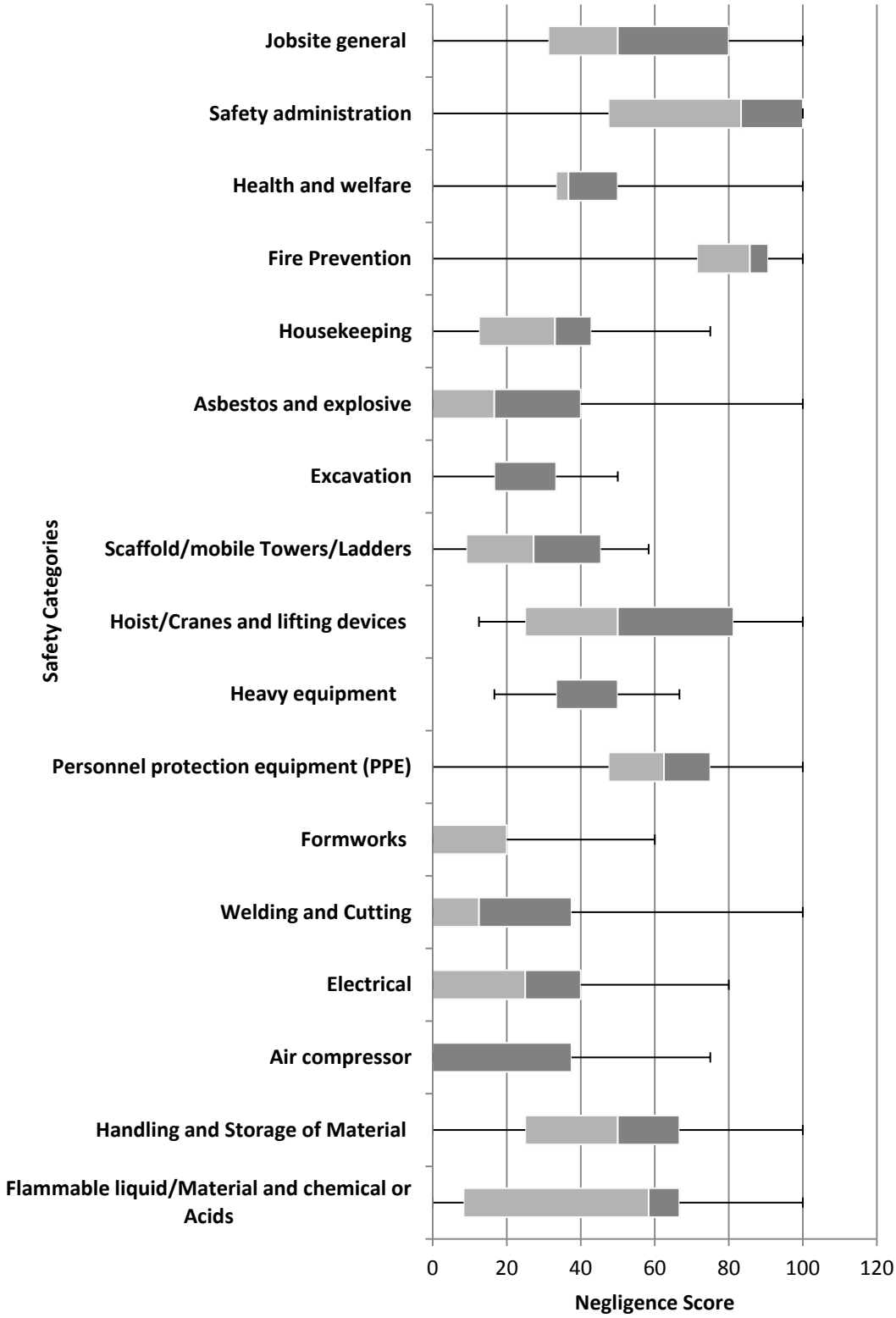

Figure 5-1 The boxplots for neglected categories in governmental projects

Table 5-3 Safety performance rating-Governmental projects

Safety Performance Level in Governmental Projects						
Project No	**Average Score (%)**	**Rating**				
		Poor	**Fair**	**Good**	**Very Good**	**Excellent**
01	48.8	√				
02	38.6	√				
03	61.7		√			
04	70.5			√		
05	46.1	√				
06	49.1	√				
07	57.9	√				
08	78.7			√		
09	69.4			√		
10	36.1	√				
11	58.3	√				
12	63.3		√			
13	81.5				√	
14	50.8	√				
15	79.2				√	
16	48.4	√				
17	62.5		√			
18	81.7				√	
19	30.3	√				
20	46.5	√				
21	43.9	√				
22	47.0	√				
23	76.5			√		
24	35.5	√				
25	60.5					
26	80.2				√	
27	64.7		√			
28	42.4	√				
29	66.7		√			
30	72.7			√		
31	67.2		√			
32	48.6	√				
Overall average 58.3% (Poor)		Poor (50%)	Fair (18.75%)	Good (15.62%)	Very Good (12.5%)	Excellent
		16 Projects	6 Projects	5 Projects	4 Projects	null

5.3.2 Safety Performance Level-USACE Projects

The collected data from USACE projects through checklists is analyzed similar to the governmental projects. Total twenty-five construction sites of USACE projects inspected in this research. The average score for all the applicable categories is calculated and the rates are assigned on the basis of Table 5-1. The highest score in USACE projects is 92.4 percent, which is rated as “Excellent”, and the lowest score is 51.7%, which is rated as “poor” which are shown in Table 5-5. Total six projects in this group are rated as “Excellent”, ten projects as “Very good”, five projects as “good”, three projects as “fair” and only one project is rated as “poor”. Moreover, the average score of safety performance level for the USACE projects is 80.2%, which is more than 80 and is rated as very good.

In addition, the most neglected categories in USACE projects are also determined. The average score as a percentage is calculated for the same category in all twenty-five projects. This is calculated based on the percentage of negative responses i.e. “No” for each question within the category. Heavy equipment, fire prevention, and handling and storage of material are the three most neglected categories in USACE projects which are shown in Table 5-4. A box plot is also provided to display the distribution of the negligence score between the categories as minimum, first quartile, median, third quartile, and maximum as shown in Figure 5-2.

Table 5-4 Ranks of neglected categories-USACE projects

No	Category	Min Negligence score	Max Negligence score	St. Dev	Safety Negligence Index	Rank
01	Jobsite General	0.00	40.00	12.25	12.80	12
02	Safety administration	0.00	66.67	24.46	14.93	9
03	Health and welfare	0.00	60.00	17.77	14.00	10
04	Fire Prevention	12.50	100.00	24.38	42.40	2
05	Housekeeping	0.00	37.50	9.53	4.57	16
06	Asbestos and explosive	0.00	16.67	4.3	1.11	17
07	Excavation	0.00	33.33	12.73	10.00	14
08	Scaffold/mobile Towers/Ladders	0.00	63.63	16.12	13.39	11
09	Hoist/Cranes and lifting devices	0.00	57.14	15.45	28.01	5
10	Heavy equipment	33.33	83.33	15.21	43.33	1
11	Personnel protection equipment (PPE)	0.00	75.00	24.01	34.07	4
12	Formworks	0.00	60.00	18.37	10.40	13
13	Welding and Cutting	0.00	75.00	25.61	20.83	6
14	Electrical	0.00	50.00	14.57	5.83	15
15	Air compressor	0.00	100.00	36.89	20.00	7
16	Handling and Storage of Material	0.00	100.00	27.78	34.33	3
17	Flammable liquid/Material and chemical or Acids	0.00	66.67	27.37	18.75	8

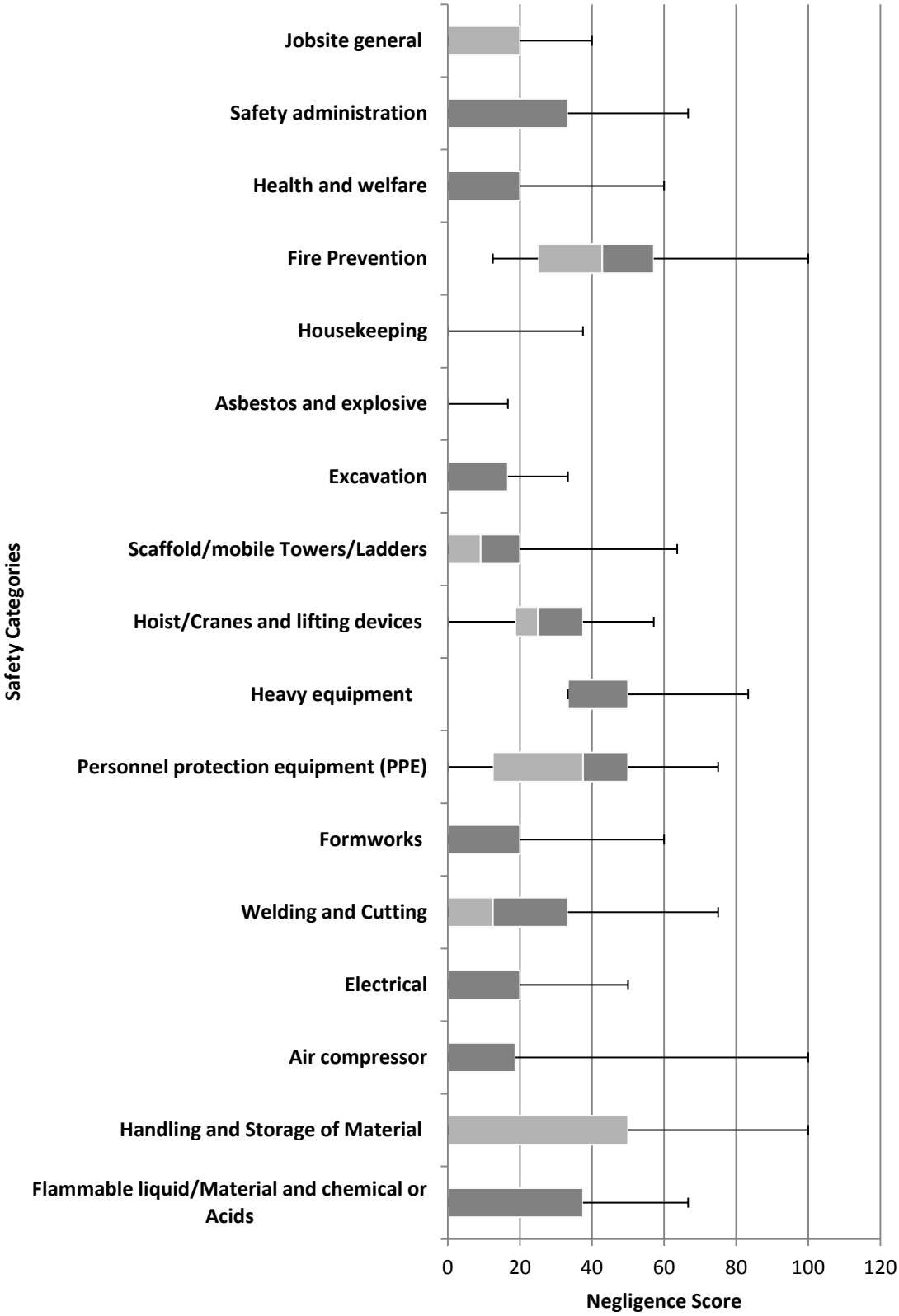

Figure 5-2 The box plots for neglected categories in USACE projects

Table 5-5 Safety performance rating-USACE projects

Safety Performance Level- USACE Projects						
Project	**Average Score (%)**	**Rating**				
		Poor	**Fair**	**Good**	**Very Good**	**Excellent**
01	84.4				√	
02	70.9			√		
03	51.7	√				
04	90.3					√
05	63.1		√			
06	65.0		√			
07	79.3				√	
08	86.7				√	
09	73.0			√		
10	79.2				√	
11	75.4			√		
12	88.7				√	
13	81.6				√	
14	76.0			√		
15	95.5					√
16	88.1				√	
17	81.3				√	
18	89.6					√
19	91.9					√
20	91.2					√
21	92.4					√
22	61.9		√			
23	86.8				√	
24	88.3				√	
25	71.6			√		
Overall Average 80.2% (Very Good)		Poor (4%)	Fair (12%)	Good (20%)	Very Good (40%)	Excellent (24%)
		1 Project	3 Projects	5 Projects	10 Projects	6 Projects

5.3.3 Comparison between USACE and Afghanistan Government Safety Performance Levels

Spearman's rank correlation coefficient or Spearman's Rho which is often donated by Greek letter (ρ) or (r_s) measures the strength and direction of association between two ranked variables. It assesses how well the relationship between two variables can be described using a monotonic function. The Spearman rank correlation coefficient r_s computed for all categories except categories that are not applicable. Out of seventeen categories only eight categories are applicable between all projects of both types of the contractors. The eight applicable categories in all projects are ranked based on their safety performance score which are shown in Table 5-6

Table 5-6 Applicable categories in All projects of both types of the contractors

Ranks for applicable Divisions in both types of the projects					
No	**Safety Division**	**USACE Ranks**	**Gov Ranks**	**Difference**	**Square of D**
01	Jobsite General	4	6	-2	4
02	Safety administration	7	8	-1	1
03	Health and welfare	6	5	1	1
04	Housekeeping	1	4	-3	9
05	Excavation	2	2	0	0
06	Scaffold/mobile Towers/Ladders	5	3	2	4
07	Personnel protection equipment (PPE)	8	7	1	1
08	Formworks	3	1	2	4

The output of coefficient Rho gives a numerical index of relation between the ranks of the categories based on the following formula.

$$r_s = 1 - \frac{6\sum 24}{8(8^2 - 1)} = 0.714$$

A critical value of r_s is needed to test the alternative hypothesis (Ha) that governmental and USACE projects generally agree on the important ranking of the divisions against the null hypothesis (Ho), which says that there is no association between the ranks. Using the table of critical values of Spearman's rank correlation coefficient, with $\alpha = 0.05$ level of significance and N=8 is equal to 0.643 (Appendix C). Since the calculated value of r_s is larger than the critical value, then the null hypothesis is rejected at the $\alpha = 0.05$ level of significance. It appears that there is some agreement between the two ranks in both types of the projects i.e. the USACE and the Afghanistan government projects. The Spearman rank correlation coefficient also calculated in SPSS to show the confidence level in manual calculation. The SPSS value for Spearman rank correlation coefficient has been shown in Table 5-7 which is similar to the index achieved by equation (5-2).

Table 5-7 Spearman rank correlation coefficient by SPSS

Correlations

			USACE	GOV
Spearman's rho	USACE	Correlation Coefficient	1.000	.714*
		Sig. (1-tailed)		.023
		N	8	8
	GOV	Correlation Coefficient	.714*	1.000
		Sig. (1-tailed)	.023	
		N	8	8

*. Correlation is significant at the 0.05 level (1-tailed).

Similarly, The Mann-Whitney U test is used to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed. In this research, the Mann-Whitney U test is applied on the average performance scores of the projects in both types of the contractors. The finding of the test revealed that null hypothesis is rejected which says: average performance scores of

USACE projects are equal to average performance scores of the Afghanistan governments' projects. The result of the test shows that there is statistically difference between these two groups, which is shown in Table 5-8 and Figure 5-3.

Table 5-8 Hypothesis summary for Mann-Whitney test

Hypothesis Test Summary			
Null Hypothesis	**Test**	**Sig**	**Decision**
The distribution of Performance score is the same across categories of the company	Independent Samples Mann-Whitney U Test	0.000	Reject the null hypothesis
Asymptotic Significance is displayed. The significance level is 0.05			
Ranks			
company	N	Mean Rank	Sum of Ranks
USACE	25	41.1	1027.5
Governmental	32	19.55	625.5
Test Statistics			
Mann-Whitney U	97.5		
Wilcoxon W	625.5		
Z	-4.865		
P Value	0.000		

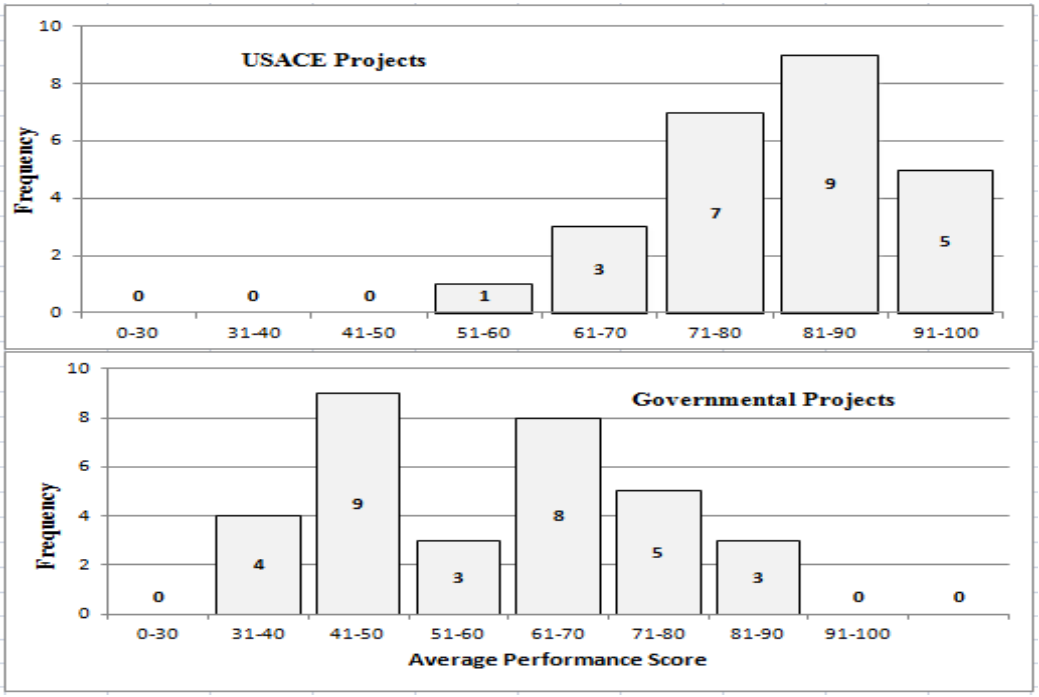

Figure 5-3 Mann-Whitney bar charts for difference in projects of the contractors

The average performance score of the project also indicated that there is huge difference between performances of both types of the contractors, which is shown in Table 5-9.

Table 5-9 The average safety score, variance and standard deviations

Contractor	Variance	Standard Deviations	Average Safety Score
U.S. Army Corps of Engineers Projects	127.64	11.3	80.2
Afghanistan Government Projects	224.61	14.99	58.3

In addition, same calculation method of scoring and rating is used to assess the safety performance level of the two groups. The only difference exists in the numbers of inspected construction sites i.e. out of fifty-seven inspected construction sites thirty-two sites are belong to Afghanistan government's contractors and twenty-five are related to USACE contractors. The safety performance level in Afghanistan's government projects is lower than USACE projects e.g. the highest score in governmental projects is 81.7% while the highest score for USACE projects is 95.5%. Similarly, the overall scoring of government projects is 58.3%, which is recorded as "Poor" while the overall scoring of the USACE projects, is 80.2%, which is considered as "Very Good" which is shown in Table 5-9.

Similarly, the most neglected factors also determined based on negative responses i.e. No response to each question in a category. The result of the calculation shows difference in most neglected factors in both types of the contractors, which are shown in Table 5-10. In addition, ranking of most neglected factor within the most neglected categories also calculated for three high ranked most neglected categories for both types of the contractors which are shown in Table 5-11.

Table 5-10 Most neglected categories and ranks in both types of the contractors

No	Division	GOV Ranks	USACE Rank
01	Jobsite General	5	12
02	Safety administration	2	9
03	Health and welfare	10	10
04	Fire Prevention	1	2
05	Housekeeping	11	16
06	Asbestos and explosive	7	17
07	Excavation	15	14
08	Scaffold/mobile Towers/Ladders	12	11
09	Hoist/Cranes and lifting devices	4	5
10	Heavy equipment	9	1
11	Personnel protection equipment (PPE)	3	4
12	Formworks	17	13
13	Welding and Cutting	14	6
14	Electrical	13	15
15	Air compressor	16	7
16	Handling and Storage of Material	6	3
17	Flammable liquid/Material and chemical or Acids	8	8

Table 5-11 Sub-ranks of most neglected categories

No	USACE first three most neglected categories			No	Government projects first three most neglected categories		
1	**Heavy equipment**	**Score**	**Rank**	**1**	**Fire Prevention**	**Score**	**Rank**
1.1	Regular inspection and maintenance carried out	6	3	1.1	Adequate/Proper type Fire extinguisher available	10.19	6
1.2	Backup alarms are working and are audible	2	4	1.2	Fire extinguisher inspection performed (periodically)	11.38	4
1.3	Lights, brakes, warning signals are operative	2	4	1.3	Fire Extinguisher properly located	11.26	5
1.4	Seat belts provided and used in equipment with ROPS	16	2	1.4	Fire watches available	13.76	1
1.5	Operators have licenses	0.67	6	1.5	Flammable/combustibles materials properly stored	5.03	8
1.6	Operation manual available	16.67	1	1.6	Adequate water barrels/buckets available	9.29	7
2	**Fire Prevention**	**Score**	**Rank**	1.7	Hydrants are clear and access to public thoroughfare is open	12.95	2
2.1	Adequate/Proper type Fire extinguisher available	2.61	7	1.8	"No smoking" signs posted and enforced	12.57	3
2.2	Fire extinguisher inspection performed (periodically)	4.43	6	**2**	**Safety administration**	**Score**	**Rank**
2.3	Fire Extinguisher properly located	4.58	5	2.1	Accidents report/inspection reports available	7.92	6
2.4	Fire watches available	12.42	1	2.2	Safety coordinator around	12.19	3
2.5	Flammable/combustibles materials properly stored	1.29	8	2.3	Fire/safety inspection log available	12.08	4
2.6	Adequate water barrels/buckets available	7.81	3	2.4	Site safety meeting/program conducted (periodically)	12.71	2
2.7	Hydrants are clear and access to public thoroughfare is open	7.40	4	2.4	Safe work permit procedures followed	11.56	5
2.8	"No smoking" signs posted and enforced	10.30	2	2.6	Confined space entry permit procedures followed	13.79	1
3	**Handling and Storage of Material**	**Score**	**Rank**	**3**	**Personnel protection equipment (PPE)**	**Score**	**Rank**
				3.1	Eye protection used	11.87	2
				3.2	Face protection (glasses, goggles, shields) used	11.60	4
3.1	Material properly storage and stocked	1	4	3.3	Hearing protection used	13.57	1
3.2	Dust protection used	16.33	1	3.4	Respirators and masks used for harmful dust, asbestos, sand blasting, welding etc.	11.82	3
3.3	Loads lifted correctly	3	3	3.5	Head protection available	4.24	7
3.4	Shelves, racks, and overhead storage load rated	15.22	2	3.6	Hand and foot protection available	5.13	6
				3.7	Safety belt and lanyards utilized	10.43	5

In line with above, there is a significant difference between USACE Contractors and Afghanistan government contractors from inspected point of view as well. Most USACE contractors who are international, joint venture or national large companies do have a safety policy, follow insurance regulations of contract, and there is a budget for safety performance. They also have a permanent safety department in their company organizational structure and maintain full time safety personnel on construction sites. However, construction workers are not aware of safety orientation and policy that is mandated by the safety department. On the other hand, for most of Afghanistan government's contractors, maximizing profit is their primary concern and as such, they do try to cut corners to squeeze their spending. Unfortunately, safety requirements are one of the areas that are harshly affected by cost cutting including: training budget, workers insurance, adequate numbers of safety personnel on construction sites. Although, governmental contract documents contain strict safety regulations but in reality these requirements remain on papers only. Therefore, unsafe conditions can be easily observed in many construction sites, with more severity in Afghanistan government's projects where workers are subjected to various serious hazards.

5.4 Conclusion and Discussion

This research provides an intensive evaluation for construction sites safety in Afghanistan. In general, construction projects in Afghanistan are owned by either USACE or Afghanistan government. The research developed a construction site safety checklist that assesses one hundred and four site safety questions over seventeen safety categories. The checklist is developed based on a comprehensive literature review of

critical construction site safety items and interviews of construction practitioners in Afghanistan. The research aimed to evaluate both types of contractors in Afghanistan (USACE, and government). It starts by evaluating thirty two government contractors' construction projects sites. The evaluation revealed the most neglected constriction safety categories based on the Safety Neglected Index (SNI). Out of the seventeen categories, it is found that the fire prevention is the most neglected category in government contractors' construction sites. Similarly, the research evaluated twenty five USACE contractors' construction sites. The SNI results show that heavy equipment safety category is the most neglected safety category for USACE projects.

The research also provides a general safety classification (based on safety performance scores) of the level of safety in construction projects sites i.e. " Poor", fair, good, very good, and excellent. Its results classify governmental projects as "poor" and USACE projects is "very good".

There are several reasons behind the poor safety performance in Afghanistan government's projects. Most of the Afghanistan government's contractors do not have safety-training programs for the employees; therefore, no orientation for new staff or workers is conducted, hazards are not pointed out, and no safety meetings are held. Employees are required to learn from their own mistakes or experience. In addition, lack of medical facilities, housing, and substandard sanitation exist in governmental projects as well.

Generally, injuries are unreported in both USACE and Afghanistan government's projects; in case of injuries, the employees might receive first aid or a preliminary

medical care in large contractors of USACE projects while in governmental projects the situation is completely different where workers do not receive first aid or preliminary medical care. In most of the cases, workers themselves consider accidents as due to their own negligence, and accept that construction is a dangerous occupation. Contractors do not report injuries or death to insurance or other responsible authorities in order not to vilify their reputation as unsafe company which jeopardize their chances to win new contracts. As an example, for any accident that takes place on-site due to lack of safety practices, the accidents are unreported and the contractors try to compensate the case with cash payment and take advantage of the poverty of the workers. On the other hand, workers hesitate to claim due to corrupted legislative authorities and accept the compensation inevitably. Sadly, it is widely believed that one of the major factors that prevent Afghanistan from developing a construction safety program is the pervasive corruption and subcontracting the projects. Projects are usually sub-contracted several times, which definitely will affect the safety performance level. Often the prime contractors have better safety performance record than the subcontractors (usually not qualified) and they get benefit of this in bedding or tenders. In addition, Afghanistan government's contractors and USACE subcontractors do not follow maintenance and inspection schedules for construction equipment which lead to have more frequency of breakdowns. This approach leads to loss of time, idle workers, and project delays.

Poor safety performance on construction jobsites can be also related to the workforce. Many workers demonstrate ignorance and lack of understanding of the tasks and needed safety orientation due to the fact that illiteracy amongst skilled laborers is rampant in Afghanistan especially in governmental projects. In addition, most of the workers are

under the influence of economic problems. Unfortunately, this affects the workmanship and psychological behavior of the workforce and enforce them to cave down to accept unethical contractors' pressure and unsafe work conditions.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

This chapter provides a brief summary relevant to the thesis findings, contribution, and future directions of research.

6.1 Summary and Conclusion

The research aimed at two main key objectives, namely: assessment of critical safety factors that affect safety performance at construction industry and assessment of safety performance level in construction sites. The objectives of the thesis are limited to two types of contractors in Afghanistan's construction industry, namely: USACE, and governments' contractors.

Twenty-nine safety factors were identified from the literature review and their impact on safety performance are evaluated based on five point Likert importance scale. The questionnaire sent to construction contractors who work with USACE and Afghanistan's government in Afghanistan. The gathered data through the questionnaires were statistically analyzed and all the factors ranked according to Relative Importance Index (RII). The result for factors assessment shows that there are some important safety factors, which need to be paid attention, and as a result will affect the safety and health performance in construction projects positively. These factors are somewhat different in ranking for both types of the contractors. For instance, the highest ranked factors in governmental projects are; Adequate safety and health training, Availability of safety and

health policy, Usage of safety signs/signal/ barricades and in USACE projects are; Safety and health training, Limitation of Personnel Protective Equipment(PPE), and Availability of safety and health policy.

In addition, a site safety assessment checklist is developed in seventeen categories and each category has several safety related questions. The research assessed construction sites safety for fifty seven projects in Afghanistan (twenty five USACE projects, and thirty two governmental projects). The collected data through checklists are also statistically analyzed and average performance score is calculated for each category. The projects are evaluated against five categories: poor, fair, good, very good, and excellent. Similarly, the most neglected categories are also determined based on negative response i.e. "No" to each question within a category. The overall score for same category in all projects are determined. Moreover, Spearman Correlation coefficient Rho and Mann-Whitney U test conducted for safety performance level in both types of the contractors. The spearman correlation coefficient Rho was conducted to test alternative hypothesis which says there is some agreement between ranks of both types of the contractors. The result of the test shows rejecting of null hypothesis and higher correlation between the ranked factors of the two groups at the $\alpha = 0.05$ level of significance. Similarly, the spearman correlation coefficient Rho is calculated for common categories between USACE and government contractors. It was found that only eight categories are common for both types of contractors. The result of the test shows rejecting the null hypothesis which says; there is no general agreement between the two groups. It was found that there is some agreement between the two ranks in both the USACE and the governmental projects.

In addition, it was also found that safety performance level in USACE projects is better than Afghanistan's government projects. The overall average percentage of government projects is 58.3%, which is recorded as "Poor" while the overall average percentage of the USACE projects, is 80.2%, which is classified as "Very Good". The most neglected categories for both types of the contractors are; Heavy equipment, Fire prevention, Safety administration, Handling and storage of materials, and Personnel Protective Equipment (PPE).

6.2 Contribution of the Research and Recommendation

Construction industry is one of the hazardous industries not only in developing countries but also in the world due to its unique nature. The statistics of injuries, illnesses and property damage in construction are higher than other industries which construction industry in Afghanistan is not an exception. Construction industry in Afghanistan often experiences safety problems in construction projects. Therefore, the result of this study could be a great help for whom they are working in construction industry in Afghanistan. The factors that with higher ranks are critical factors that affect safety performance in construction sites. Paying attention to these factors is important which will contribute to zero or minimum injuries or property damages in construction projects. In addition, assessment of safety performance level at construction projects also gives a clear picture of safety practices of the contractors. This will help the clients and the Afghanistan's government to strengthen and give priority to safety performance in construction projects. Further, the following recommendations will be helpful to enhance safety performance level and to minimize or prevent injuries, illnesses and damage of property in

Afghanistan construction industry. The recommendations are listed based on the findings of the research;

- It is recommended to all who work in construction industry in Afghanistan to give priority for highly ranked factors of the research. These are the most critical factors that affect safety performance level with higher degree. Priority to these factors will help to enhance safety awareness among workers and minimize the safety accidents/incidents at construction sites. In addition, these factors also affect other aspects of the projects e.g. Total project duration and total cost of the project. For instance, fail to care for these factors cause injuries or loss of life, which the work will be postponed and the compensation will be provided.
- It is recommended that all contractors, especially in government projects, should employ safety personnel in construction sites. A safety budget should be allocated for safety training. Contractors should be also obliged to provide insurance premiums for their workers.
- A centralized construction safety department is recommended to be established for all ministries in Afghanistan with the following responsibilities;
    - The department should prepare same safety regulations for all contractors who work in Afghanistan and consider these regulations as part of the contract documents.
    - The department should classify the construction companies as per their safety performances and send information to all clients of the projects.
    - The department should have the authority to inspect safety performance of contractors during the execution of projects.

- It is recommended to control the process of subcontracting. Usually, the main contractors records of safety is validated at the tendering stage but the there is no validation of safety records for subcontractors. Hence, the consent of the project owner (USACE, or government) should be assured before the subcontract. A black list can be prepared for sub-contractors with records of safety violations.

6.3 Future Research

- Since limited research studies relevant to safety at construction are available in Afghanistan, therefore, research windows are open to researchers. There are several areas for future research such as; assessing safety performance of small residential projects and nongovernmental projects, assessing injuries and accident rates in construction projects, assessing causes of injuries and accidents, assessment of factors in (Appendix A) in further details, developing safety assessment checklist based on weights to each factors and so on.

References

Ahmed, S. M., Kwan, J. C., Ming, F. Y. W. & Ho, D. C. P. (2000). Site Safety Management in Hong Kong. *Journal of Management in Engineering*, *16*(6), 34–42.

Aksorn, T. & Hadikusumo, B. H. W. (2008). Critical success factors influencing safety program performance in Thai construction projects. *Safety Science*, *46*(4), 709–727.

Amiri, M. (2016). Toward Occupational Safety and Health Management in Afghanistan's Construction Industry, (June), 209–213.

Amiri, M. & Hamidi, M. G. (2015). Developing a Standard Safety manual for the Construction Industry in Afghanstian.pdf.

Amiri, M., Safi, M. R., Moshtaq, M. S. & Eshaqzai, H. (2015). Investigation of Using Personnel Protective Equipment at Construciton Sites in Herat Province.pdf.

Ardeshir, A., Alipouri, Y. & Besmel, P. (2014). Investigation of factors influencing safety performance of workers in construction sites using fuzzy analytic hierarchy process (Case study: Khuzestan province)3. *Iran Occupational Health*, *11*, 11.

Baig, M. M. (2001). *Safety assessment of industrial construction projects in Saudi Arabia*. KING FAHD UNIVERSITY OF PETROLEUM & MINERALS.

CHINADAILY News. (2004). Four died in Afghan hospital collapse. Retrieved November 29, 2016, from http://www.chinadaily.com.cn/english/doc/2004-07/28/content_352187.htm

Choudhry, R. . & Zahoor, H. (2016). Strengths and weaknesses of safety practices to improve safety performance in construction projects in Pakistan. *Journal of Professional Issues in Engineering Education and Practice*, *142*(4), 1–10.

Choudhry, R. M. & Fang, D. (2008). Why operatives engage in unsafe work behavior: Investigating factors on construction sites. *Safety Science*, *46*(4), 566–584.

Enshass, A., Choudhry, R. M. & Aqaad, M. (2013). IDENTIFING CAUSES OF SAFETY DEGRADATION IN CONSTRUCTION PROJECTS IN PALESTINE. *International Journal of Construction Project Management*, *5*(1), 1944–1436.

Enshassi, A., Choudhry, R. M., Mayer, P. E. & Shoman, Y. (2008). Safety performance of subcontractors in the Palestinian construction industry. *Journal of Construction in Developing Countries*, *13*(1), 51–62.

Enshassi, A., Mayer, P. E., Mohamed, S. & El-Masri, F. (2007). Perception of Construction Managers Towards Safety in Palestine. *International Journal of Construction Management*, *7*(2), 41–51.

Fang, D. P., Huang, X. Y. & Hinze, J. (2004). Benchmarking Studies on Construction Safety Management in China.: Discovery Service for University of Alberta Libraries. *Journal of Construction Engineering and Management*, *130*(3), 424–432.

Farooqui, R. U., Arif, F. & Rafeeqi, S. F. . (2008). Safety Performance in Construction Industry of Pakistan. In *First International Conference on Construction In Developing Countries (ICCIDC–I) "Advancing and Integrating Construction Education, Research & Practice" August 4-5, 2008, Karachi,, Pakistan* (p. 14).

HASSAN, C. R. C., O.J. BASHA & HANAFI, W. H. W. (2007). Perception of building consruction workers towards safety, health and environment. *Journal of Engineering Science and Technology*, *2*(3), 271–279.

Heravi, G. & Nabizadeh Rafsanjani, H. (2011). Critical Safety Factors in Construction Projects. *Advanced Materials Research*, *255–260*, 3921–3927.

Hu, K., Rahmandad, H., Smith- Jackson, T. & Winchester, W. (2011). Factors influencing the risk of falls in the construction industry: a review of the evidence. *Construction Management and Economics*, *29*(4), 397–416.

Hughes, P. & Ferrett, E. (2007). *Introduction to HEALTH AND SAFETY IN CONSTRUCTION* (Second Edi). Elsevier Ltd.

International Labour Organization. (1995). Safety , health and welfare on construction sites. Retrieved from http://www.ilo.org

Jannadi, M. O. & Al- Sudairi, A. (1995). Safety management in the construction industry in Saudi Arabia. *Building Research & Information*, *23*(1), 60–63.

Jannadi, M. O. & Assaf, S. (1998). Safety assessment in the built environment of Saudi Arabia. *Safety Science*, *29*(1), 15–24.

Jannadi, O. A. & Almishari, S. (2003). Risk Assessment in Construction. *Journal of Construction Engineering and Management*, *129*(5), 492–500.

Jannadi, O. A. & Bu-Khamsin, M. S. (2002). Safety factors considered by industrial contractors in Saudi Arabia. *Building and Environment*, *37*(5), 539–547.

Kish, L. (1995). *Survey Sampling*. New York.

Klein, J. A. (2009). Two Centuries of Process Safety at DuPont, 114–122.

Konda, S., Tiesman, H. M. & Reichard, A. A. (2016). Fatal traumatic brain injuries in the construction industry, 2003−2010. *American Journal of Industrial Medicine*, *59*(3), 212–220.

Le, Y., Shan, M., Chan, A. P. C. & Hu, Y. (2014). Overview of Corruption Research in Construction. *Journal of Management in Engineering*, *30*(4), 2514001.

Mittal, V. (2016). Ten Lessons Learned about Host-Nation Construction in Afghanistan.

MILITARY REVIEW, (October), 9.

Mosly, I. (2015). Safety Performance in the Construction Industry of Saudi Arabia. *International Journal of Construction Engineering and Management*, *4*(6), 238–247.

Murie, F. (2007). Building Safety—An International Perspective. *International Journal of Occupational and Environmental Health*, *13*(1), 5–11.

National Research Council. (2000). *Safe Work in the 21st Century: Education and Training Needs for the Next Decade's Occupational Safety and Health Personnel*. NATIONAL ACADEMY PRESS Washington, DC.

Priyadarshani, K., Karunasena, G. & Jayasuriya, S. (2013). Construction Safety Management Assessment Framework for Developing Countries: a Case of Sri Lanka. *Construction in Developing Countries*, (January 2013), 20.

RadioAzadi News. (2013). Radio Free Europe / Radio Liberty. Retrieved November 29, 2016, from http://www.azadiradio.com/

Reese, C. D. & Eidson, J. V. (2006). *Handbook of OSHA Construction Safety and Health, Second Edition*.

Reese, D. C. D. (2008). *Occupational Health and Safety Management a Practical Approach* (Second Edi). CRC Press Taylor & Francis Group.

Rinker, M. E. (2003). AN EVALUATION OF SAFETY PERFORMANCE, *4*(1), 5–15.

Sawacha, E., Naoum, S. & Fong, D. (1999). Factors affecting safety performance on construction sites. *International Journal of Project Management*, *17*(5), 309–315.

Shuai, L. & Li, H. (2013). Problems and Effective Countermeasures in Construction Safety Management. *Applied Mechanics and Materials*, *438–439*, 1702–1705.

Special Inspector General for Afghanistan Reconstruction. (2009). *2009-10-26audit-10-*

02-SIGAR.pdf.

Tam, C. M., Zeng, S. X. & Deng, Z. M. (2004). Identifying elements of poor construction safety management in China. *Safety Science*, *42*(7), 569–586.

Texas Department of Insurance. (n.d.). Construction Safety Inspection Checklist. Retrieved September 14, 2016, from http://www.tdi.texas.gov/pubs/videoresource/cklgenconstru.pdf

UNESCO office in Kabul. (2017). Areas of Action Enhancement of Literacy in Afghanistan (ELA) program. Retrieved April 11, 2017, from http://www.unesco.org/new/en/kabul/education/enhancement-of-literacy-in-afghanistan-ela-program/

William, M., Robert J., B. & Barbara M., B. (2013). *Introduction to Probability and Statisitics* (14th editi).

Appendix A- Survey Questionnaire

Critical Factors that affect safety and health performance in construction sites	
Education	Technical/Training ☐ Associate Degree ☐ Bachelor Degree ☐ Master Degree ☐ Doctorate Degree ☐
Position	Project Manager ☐ Safety Manager ☐ Safety Officer ☐
Years of Experience	☐ <5 ☐ 5-10 ☐ 10-15 ☐ >15
The project you are working for is funded by Afghan Government ☐ U.S Army Corps ☐	

No	**Factors**	**Degree of Importance**				
		1 Not	**2**	**3**	**4**	**5** Highest
01	Design complexity impact on safety	☐	☐	☐	☐	☐
02	Owner and main developer by-laws to safety	☐	☐	☐	☐	☐
03	Influence of weather condition on safety and health	☐	☐	☐	☐	☐
04	Impact of total project cost on safety	☐	☐	☐	☐	☐
05	Total project duration influence on safety	☐	☐	☐	☐	☐
06	Availability of safety and health policy and its impact on safety	☐	☐	☐	☐	☐
07	Incidents/ Near miss reporting	☐	☐	☐	☐	☐
08	Investigation and lesson learning from reporting of incident and near miss	☐	☐	☐	☐	☐
09	Mechanism for implementing lesson learned and investigations of incident and near miss	☐	☐	☐	☐	☐
10	limitation of evacuation plan/ fire drill	☐	☐	☐	☐	☐
11	Risk assessment	☐	☐	☐	☐	☐
12	Adequate safety and health training	☐	☐	☐	☐	☐

13	Limitation of Personnel Protective Equipment (PPE)					
14	Emergency planning/ procedure and logistic to hospitalize sever injuries					
15	Planning (Site safety plan, hazard safety management responsibility plan, etc.)					
16	Observation of safety practices on jobsite					
17	Frequently safety and health management meetings					
18	Availability of First Aid arrangement and medical personnel on jobsite					
19	Arrangement of suitable welfare facilities for workers usage					
20	Usage of safety signals/ signs/ barricades					
21	Usage of work area plan and its impact on safety.					
22	Usage of reward (incentive) and warning for safety performance					
23	Role of government and engineering society regarding safety of construction companies					
24	Human behavior/ and psychological climate					
25	Employees age and experience					
26	Lack of skill labors and illiteracy					
27	Natural environment impact on safety					
28	Good housekeeping/site security plan					
29	Machinery/equipments' safe working condition					

Appendix B- Survey Checklist

Safety assessment in construction sites in Afghanistan 1. If any of division not applicable please tick in front of that division, otherwise go ahead with questions. **2.** This is a countrywide survey and the result is not relevant to any particular firm.				
The project you are working for is funded by Afghan Government ☐ U.S Army Corps ☐				
No	**Division**	**Respond**		
01	**Jobsite General**	☐ N/A		
1.1	Posters and safety signs/warnings are posted	☐ Yes	☐ No	☐ N/A
1.2	First aid kit available and adequately stocked	☐ Yes	☐ No	☐ N/A
1.3	Emergency telephone numbers posted	☐ Yes	☐ No	☐ N/A
1.4	Traffic routes identified	☐ Yes	☐ No	☐ N/A
1.5	Jobsites fenced	☐ Yes	☐ No	☐ N/A
02	**Safety administration**	☐ N/A		
2.1	Accidents report/inspection reports available	☐ Yes	☐ No	☐ N/A
2.2	Safety coordinator around	☐ Yes	☐ No	☐ N/A
2.3	Fire/safety inspection log available	☐ Yes	☐ No	☐ N/A
2.4	Site safety meeting/program conducted (periodically)	☐ Yes	☐ No	☐ N/A
2.5	Safe work permit procedures followed	☐ Yes	☐ No	☐ N/A
2.6	Confined space entry permit procedures followed	☐ Yes	☐ No	☐ N/A
03	**Health and welfare**	☐ N/A		
3.1	Medical facilities/supplies available	☐ Yes	☐ No	☐ N/A
3.2	Smoking areas designated	☐ Yes	☐ No	☐ N/A
3.3	Washing facilities available	☐ Yes	☐ No	☐ N/A
3.4	Drinking water and cups available	☐ Yes	☐ No	☐ N/A
3.5	Toilet facilities/sanitation available	☐ Yes	☐ No	☐ N/A
3.6	Adequate ventilation provided	☐ Yes	☐ No	☐ N/A
04	**Fire Prevention**	☐ N/A		
4.1	Adequate/Proper type Fire extinguisher available	☐ Yes	☐ No	☐ N/A
4.2	Fire extinguisher inspection performed (periodically)	☐ Yes	☐ No	☐ N/A
4.3	Fire Extinguisher properly located	☐ Yes	☐ No	☐ N/A
4.4	Fire watches available	☐ Yes	☐ No	☐ N/A
4.5	Flammable/combustibles materials properly stored	☐ Yes	☐ No	☐ N/A

4.6	Adequate water barrels/buckets available	Yes	No	N/A
4.7	Hydrants are clear and access to public thoroughfare is open	Yes	No	N/A
4.8	"No smoking" signs posted and enforced	Yes	No	N/A
05	**Housekeeping**			N/A
5.1	Site access roads/ walkways clear	Yes	No	N/A
5.2	Security fences/gates installed	Yes	No	N/A
5.3	Site access signs posted	Yes	No	N/A
5.4	Waste containers provided and used	Yes	No	N/A
5.5	Regular disposal of waste and trash performed	Yes	No	N/A
5.6	Site clean-up (nails, boards, debris, snow, grease etc removed)	Yes	No	N/A
5.7	Adequate lighting is available	Yes	No	N/A
5.8	Materials properly stacked	Yes	No	N/A
06	**Asbestos and explosive**			N/A
6.1	If unexpected presence detected, Work is stopped	Yes	No	N/A
6.2	Owner been notified	Yes	No	N/A
6.3	Area secured	Yes	No	N/A
6.4	Experienced and trained personnel handling explosives	Yes	No	N/A
6.5	Explosives properly stored	Yes	No	N/A
6.6	All blasting operations conducted between sun-up and sundown	Yes	No	N/A
07	**Excavation**			N/A
7.1	Holes, trenches, and cuts over 5 feet deep shored	Yes	No	N/A
7.2	Necessary ladder provided	Yes	No	N/A
7.3	Excavation barricaded	Yes	No	N/A
7.4	Equipment placed away from edges	Yes	No	N/A
7.5	Barriers/warning signs/lights provided	Yes	No	N/A
7.6	Access/egress is adequate	Yes	No	N/A
08	**Scaffold/mobile Towers/Ladders**			N/A
8.1	Scaffold tied to structures	Yes	No	N/A
8.2	Guard rails and toe boards provided	Yes	No	N/A
8.3	Ropes and cables are in good condition	Yes	No	N/A
8.4	Fall protection available and in use	Yes	No	N/A
8.5	All structural members free from defects and meet safety requirement?	Yes	No	N/A
8.6	All connections are secure	Yes	No	N/A
8.7	Planking cleats are in place	Yes	No	N/A
8.8	Scaffold installed Plumb and level	Yes	No	N/A

8.9	Screen and shield provided	Yes	No	N/A
8.10	ladders are in good condition	Yes	No	N/A
8.11	Do fixed ladders in excess of 20 feet have fall protection	Yes	No	N/A
8.12	Mobile towers have railing around	Yes	No	N/A
09	**Hoist/Cranes and lifting devices**		N/A	
9.1	Crane and lifting devices operate with Afghani licensed operators	Yes	No	N/A
9.2	Load radius indicator is available	Yes	No	N/A
9.3	Safety latches (hooks) available	Yes	No	N/A
9.4	Slings and chain are in good condition	Yes	No	N/A
9.5	Safe load chart (Pashto/Dari.) is available	Yes	No	N/A
9.6	Alarms are working and are audible	Yes	No	N/A
9.7	Outriggers used properly	Yes	No	N/A
9.8	Signal man/rigger where needed is around	Yes	No	N/A
10	**Heavy equipment**		N/A	
10.1	Regular inspection and maintenance carried out	Yes	No	N/A
10.2	Backup alarms are working and are audible	Yes	No	N/A
10.3	Lights, brakes, warning signals are operative	Yes	No	N/A
10.4	Seat belts provided and used in equipment with ROPS	Yes	No	N/A
10.5	Operators have licenses	Yes	No	N/A
10.6	Operation manual available	Yes	No	N/A
11	**Personnel protection equipment (PPE)**		N/A	
11.1	Eye protection used	Yes	No	N/A
11.2	Face protection (glasses, goggles, shields) used	Yes	No	N/A
11.3	Hearing protection used	Yes	No	N/A
11.4	Respirators used for harmful dust, asbestos, sand blasting, welding etc.	Yes	No	N/A
11.5	Head protection available	Yes	No	N/A
11.6	Hand and foot protection available	Yes	No	N/A
11.7	Safety belt and lanyards utilized	Yes	No	N/A
12	**Formworks**		N/A	
12.1	Forms properly installed and braced	Yes	No	N/A
12.2	Shores and supports are braced	Yes	No	N/A
12.3	Caps on rebar are used	Yes	No	N/A
12.4	Timber have adequate strength	Yes	No	N/A
12.5	Providing footing for supports	Yes	No	N/A
13	**Welding and Cutting**		N/A	

13.1	Oxygen and acetylene stored properly	Yes	No	N/A
13.2	Idle bottles are kept with caps in places	Yes	No	N/A
13.3	Electrical equipment properly grounded	Yes	No	N/A
13.4	Gas lines and power cables protected and are in good condition	Yes	No	N/A
14	**Electrical**			N/A
14.1	Equipment properly grounded	Yes	No	N/A
14.2	GFCI used and tested where required	Yes	No	N/A
14.3	Fuses provided	Yes	No	N/A
14.4	Access to breaker box is clear	Yes	No	N/A
14.5	Underground electrical/Gas line staked	Yes	No	N/A
15	**Air compressor**			N/A
15.1	Inspection for press relief valve operational performed	Yes	No	N/A
15.2	Inspection for air press gauges performed	Yes	No	N/A
15.3	Proper hose & connection available	Yes	No	N/A
15.4	Coupling safety wired Guards available	Yes	No	N/A
16	**Handling and Storage of Material**			N/A
16.1	Material properly storage and stocked	Yes	No	N/A
16.2	Dust protection used	Yes	No	N/A
16.3	Loads lifted correctly	Yes	No	N/A
16.4	Shelves, racks, and overhead storage load rated	Yes	No	N/A
17	**Flammable liquid/Material and chemical or Acids**			N/A
17.1	Containers stored in appropriate areas	Yes	No	N/A
17.2	Storage tanks are with pressure relief and properly grounded	Yes	No	N/A
17.3	Cylinders stored/secured in upright position	Yes	No	N/A

Appendix C- Spearman's (ρ) Critical Values for One-Tailed Test

n	α=0.05	α=0.025	α=0.01	α=0.005
05	0.900			
06	0.829	0.8886	0.943	
07	0.714	0.786	0.893	
08	0.643	0.738	0.833	0.881
09	0.600	0.683	0.783	0.833
10	0.564	0.648	0.745	0.794
11	0.523	0.623	0.736	0.818
12	0.497	0.591	0.703	0.780
13	0.475	0.566	0.673	0.745
14	0.457	0.545	0.646	0.716
15	0.441	0.525	0.623	0.689
16	0.425	0.507	0.601	0.666
17	0.412	0.490	0.582	0.645
18	0.399	0.476	0.564	0.625
19	0.388	0.462	0.549	0.608
20	0.377	0.450	0.534	0.591
21	0.368	0.438	0.521	0.576
22	0.358	0.428	0.508	0.562
23	0.351	0.418	0.496	0.549
24	0.343	0.409	0.485	0.537
25	0.336	0.400	0.475	0.526
26	0.329	0.392	0.465	0.515
27	0.323	0.385	0.456	0.505
28	0.317	0.377	0.448	0.496
29	0.311	0.37	0.44	0.487
30	0.305	0.364	0.432	0.478

Source (William et al., 2013)

Vitae

Name	:Mohammad Hashim Ibrahimkhil
Nationality	:Afghan
Date of Birth	:3/23/1988
Email	:hashim_abrahimkhil@hotmail.com
Address	:Charahi Qamber 5th Police District, Kabul, Afghanistan

Academic Background:

M.Sc. in Construction Engineering and Management (Aug 2015- May 2017)

Construction Engineering and Management Department, King Fahd University of Petroleum & Minerals (KFUPM) Dhahran, Saudi Arabia.

Thesis: Assessment of Safety Factors and Safety Performance in Afghanistan Construction Industry.

B.Sc. in Civil Engineering (Aug 2007-Feb 2012)

Civil and Industrial Construction Department, Construction Faculty, Kabul Polytechnic University (KPU), Kabul, Afghanistan.

Final Year Project: Architectural and structural design of seven-story office building in Kabul, Afghanistan.